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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVI. THE RETREAT OF THEOLOGY IN THE GALILEO CASE.

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ANY history of the victory of astronomical science over theology would be incomplete without some account of the retreat made by the Church from all its former positions in the Galileo case.

The retreat of the Protestant theologians was not difficult. A little skillful warping of Scripture, and a little skillful use of that time-honored phrase attributed to Cardinal Baronius, that the Bible is given to teach us, not how the heavens go, but how men go to heaven, sufficed.

But in the older Church it was far less easy. The retreat of the sacro-scientific army of Church apologists lasted through two centuries.

In spite of all that has been said by these apologists, there no longer remains the shadow of a doubt that the papal infallibility was committed fully and irrevocably against the double revolution of the earth. As the documents of Galileo's trial now published show, Paul V pushed on with all his might the condemnation of Galileo in 1616, and the condemnation in that same year of the works of Copernicus and all others teaching the motion of the earth around its own axis and around the sun. So, too, in the condemnation of Galileo in 1633, and in all the proceedings which led up to it and which followed it, Urban VIII was the central figure. Without his sanction no action could have been taken.

True, the Pope did not formally sign the degree against the Copernican theory *then;* but this came later: in 1664 Alexander VII prefixed to the Index containing the condemnations of the

works of Copernicus and Galileo and "all books which affirm the motion of the earth," a papal bull signed by himself, binding the contents of the Index upon the consciences of the faithful. This bull confirmed and approved in express terms, finally, decisively, and infallibly, the condemnation of "all books teaching the movement of the earth and the stability of the sun."*

The position of the mother Church, then, was especially difficult. The first important move in retreat by the apologists was the statement that Galileo was condemned, not because he affirmed the motion of the earth, but because he supported it from Scripture. There was a slight appearance of truth in this. Undoubtedly, Galileo's letters to Castelli and the grand duchess, in which he attempted to show that his astronomical doctrines were not opposed to Scripture, gave a new stir to religious bigotry. For a considerable time, then, this quibble served its purpose; even a hundred and fifty years after Galileo's condemnation it was renewed by the Protestant, Mallet du Pan, in his wish to gain favor from the older Church.

But nothing can be more absurd, in the light of the original documents recently brought out of the Vatican archives, than to make this contention now. The letters of Galileo to Castelli and the grand duchess were not published until after the condemnation; and, although the Archbishop of Pisa had endeavored to use them against him, they were but casually mentioned in 1616, and entirely left out of view in 1633. What was condemned in 1616 by the Sacred Congregation held in the presence of Pope Paul V, as "*absurd, false in theology, and heretical, because absolutely contrary to Holy Scripture,*" was the proposition that "*the sun is the center about which the earth revolves*"; and what was condemned as "*absurd, false in philosophy, and from a theologic point of view, at least, opposed to the true faith,*" was the proposition that "*the earth is not the center of the universe and immovable, but has a diurnal motion.*"

And again, what Galileo was made, by express order of Pope Urban, and by the action of the Inquisition under threat of torture, to abjure in 1633 was "*the error and heresy of the movement of the earth.*"

What the Index condemned under sanction of the bull issued by Alexander VII in 1664 was, "*all books teaching the movement of the earth and the stability of the sun.*"

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* See Rev. William W. Roberts, The Pontifical Decrees against the Doctrine of the Earth's Movement, London, 1885, p. 94; and for the text of the papal bull, Speculatores domus Israel, pp. 132, 133. See also St. George Mivart's article in the Nineteenth Century for July, 1885. For the authentic publication of the bull, see preface to the Index of 1664, where the bull appears, signed by the Pope. The Rev. Mr. Roberts and Mr. St. George Mivart are Roman Catholics, and both acknowledge that the papal sanction was fully given.

What the Index, prefaced by papal bulls, binding its contents upon the consciences of the faithful, for two hundred years steadily condemned, was "*all books which affirm the motion of the earth.*"

Not one of these condemnations was directed against Galileo "for reconciling his ideas with Scripture."*

Having been dislodged from this point, the Church apologists sought cover under the statement that Galileo was condemned, not for heresy, but for contumacy, and for wanting in respect to the Pope.

There was a slight chance, also, for this quibble: no doubt Urban VIII, one of the haughtiest of pontiffs, was induced by Galileo's enemies to think that he had been treated with some lack of proper etiquette: first, by Galileo's adhesion to his own doctrines after his condemnation in 1616; and, next, by his supposed reference in the Dialogue of 1632 to the arguments which the Pope had used against him.

But it would seem to be a very poor service rendered to the doctrine of papal infallibility to claim that a decision, so immense in its consequences, could be influenced by the personal resentment of the reigning pontiff.

Again, as to the first point, the very language of the various sentences shows the folly of this assertion; these sentences speak steadily of "heresy," and never of "contumacy." As to the last point, the display of the original documents settled that forever. They show Galileo from first to last as most submissive toward the Pope, and patient under the papal arguments and exactions. He had, indeed, expressed his anger at times against his traducers; but to hold this the cause of the judgment against him is to degrade the whole proceedings, and to convict Paul V, Urban VIII, Bellarmin, the other theologians, and the Inquisition, of direct falsehood, since they assigned entirely different reasons for their conduct. From this position, therefore, the assailants retreated.†

The next rally was made about the statement that the persecution of Galileo was the result of a quarrel between Aristotelian professors on one side and professors favoring the experimental

* See the original trial documents, copied carefully from the Vatican manuscripts; see the Roman Catholic authority, L'Epinois, especially p. 35, where the principal document is given in its original Latin; see, also, Gebler, Die Acten des Galilei'schen Processes, for still more complete copies of the same documents. For minute information regarding these documents and their publication, see Favaro, Miscellanea Galileana Inedita, forming vol. xxii, part iii, of the Memoirs of the Venetian Institute for 1887, and especially pp. 891 and following.

† The invention of the "contumacy" quibble seems due to Monsignor Marini, who appears also to have manipulated the original documents to prove it. Even Whewell appears to have been somewhat misled by him, but Whewell wrote before L'Epinois had shown all the documents, and under the supposition that Marini was an honest man.

method on the other. But this position was attacked and carried by a very simple statement. If the divine guidance of the Church is such that it can be dragged into a professorial squabble, and made the tool of a faction in bringing about a most disastrous condemnation of a proved truth, how did the Church at that time differ from any human organization sunk into decrepitude, managed nominally by simpletons, but really by schemers? If that argument be true, the condition of the Church was worse than its enemies have declared it: amid the jeers of an unfeeling world the apologists sought new shelter.

The next point at which a stand was made was the assertion that the condemnation of Galileo was "provisory"; but this proved a more treacherous shelter than the other. When doctrines have been solemnly declared, as those of Galileo were solemnly declared by the highest authority in the Church, "contrary to the sacred Scriptures," "opposed to the true faith," and "false and absurd in theology and philosophy;"—to say that such declarations are "provisory," is to say that the truth held by the Church is not immutable; from this, then, the apologists retreated.*

Still another contention was made—in some respects more curious than any other;—it was, mainly, that Galileo "was no more a victim of Catholics than of Protestants; for they more than the Catholic theologians impelled the Pope to the action taken." †

But if Protestantism could force the papal hand in a matter of this magnitude—involving vast questions of belief and far-reaching questions of policy—what becomes of "inerrancy," of special protection and guidance of the papal authority in matters of faith?

While this retreat from position to position was going on, there was a constant discharge of small-arms, in the shape of innuendoes, hints, and sophistries: every effort was made to blacken Galileo's private character; the irregularities of his early life were dragged forth, and stress even was laid upon breaches of etiquette; but this succeeded so poorly that even as far back as 1850 it was thought necessary to cover this retreat by some more careful strategy.

This strategy is instructive. The original documents of the Galileo trial had been brought during the Napoleonic conquests to Paris; but in 1846 they were returned to Rome by the French Government, on the express pledge by the papal authorities that

* This argument also seems to have been foisted upon the world by the wily Monsignor Marini.

† See the Rev. A. M. Kirsch on Professor Huxley and Evolution, in The American Catholic Quarterly, October, 1877. The article is, as a whole, remarkably fair-minded, and in the main just, as to the Protestant attitude, and as to the causes underlying the whole action against Galileo.

they should be published. In 1850, after various delays on various pretexts, the long-expected publication appeared. The personage charged with presenting them to the world was Monsignor Marini. This ecclesiastic was of a kind which has too often afflicted both the Church and the world at large. Despite the solemn promise of the papal court, the wily Marini became the instrument of the Roman authorities in evading the promise. By suppressing a document here, and interpolating a statement there, he managed to give plausible standing-ground for nearly every important sophistry ever broached to save the infallibility of the Church and destroy the reputation of Galileo. He it was who supported the idea that Galileo was "condemned, not for heresy, but for contumacy," and various other assertions as groundless.

The first effect of Monsignor Marini's book seemed useful in covering the retreat of the Church apologists. Aided by him, such vigorous writers as Ward were able to throw up temporary intrenchments between the Roman authorities and the indignation of the world.

But some time later came an investigator very different from Monsignor Marini. This was a Frenchman, M. L'Epinois. Like Marini, L'Epinois was devoted to the Church; but, unlike Marini, he could not lie. Having obtained access in 1867 to the Galileo documents at the Vatican, he published fully several of the most important, without suppression or piously-fraudulent manipulation. This made all the intrenchments based upon Marini's statements untenable. Another retreat had to be made.

And now came the most desperate effort of all. The apologetic army, reviving an idea which the popes and Church had spurned for centuries, declared that the popes *as popes* had never condemned the doctrines of Copernicus and Galileo; that they had condemned them as men simply; that therefore the Church had never been committed to them; that the condemnation was made by the cardinals of the Inquisition and Index; and that the Pope had evidently been restrained by interposition of Providence from signing their condemnation. Nothing could show the desperation of the retreating party better than jugglery like this. The facts are, that in the official account of the condemnation by Bellarmin, in 1616, he declares distinctly that he makes this condemnation "in the name of his Holiness the Pope." *

Again, from Pope Urban downward, among the Church authorities of the seventeenth century, the decision was always acknowledged to be made by the Pope and the Church. Urban VIII spoke of that of 1616 as made by Pope Paul V and the Church, and of that of 1633 as made by himself and the Church.

* See the citation from the Vatican manuscript given in Gebler, p. 78.

Pope Alexander VII in 1664, in his bull "Speculatores," solemnly sanctioned the condemnation of all books affirming the earth's movement.*

When Gassendi attempted to raise the point that the decision against Copernicus and Galileo was not sanctioned by the Church as such, an eminent theological authority, Father Lecazre, rector of the College of Dijon, publicly contradicted him, and declared that it "was not certain cardinals, but the supreme authority of the Church," that had condemned Galileo; and to this statement the Pope and other Church authorities gave consent either openly or by silence. When Descartes and others attempted to raise the same point, they were treated with contempt. Father Castelli, who had devoted himself to Galileo, and knew to his cost just what the condemnation meant and who made it, takes it for granted in his letter to the papal authorities that it was made by the Church. Cardinal Querenghi, in his letters; the ambassador Guicciardini, in his dispatches; Polacco, in his refutation; the historian Viviani, in his biography of Galileo—all writing under Church inspection and approval at the time, took the view that the Pope and Church condemned Galileo, and this was never denied at Rome. The Inquisition itself, backed by the greatest theologian of the time, Bellarmin, took the same view. Not only does he declare that he makes the condemnation "in the name of his Holiness the Pope," but we have the Roman Index, containing the condemnation for nearly two hundred years, prefaced by a solemn bull of the reigning Pope binding this condemnation on the consciences of the whole Church, and declaring year after year that "all books which affirm the motion of the earth" are damnable. To attempt to face all this, added to the fact that Galileo was required to abjure "the heresy of the movement of the earth" by written order of the Pope, was soon seen to be impossible. Against the assertion that the Pope was not responsible we have all this mass of testimony, and the bull of Alexander VII in 1664.†

This contention, then, was at last utterly given up by honest

* For references by Urban VIII to the condemnation as made by Pope Paul V, see pp. 136, 144, and elsewhere in Martin, who much against his will is forced to allow this. See also Roberts, Pontifical Decrees against the Earth's Movement, and St. George Mivart's article, as above quoted; also Reusch, Der Index verbotenen Bücher, Bonn, 1885, vol. ii, pp. 29 *et seq.*

† For Lecazre's answer to Gassendi, see Martin, pp. 146, 147. For the attempt to make the crime of Galileo a breach of etiquette, see Dublin Review, as above. Whewell, vol. i, p. 283. Citation from Marini: "Galileo was punished for trifling with the authorities, to which he refused to submit, and was punished for obstinate contumacy, not heresy." The sufficient answer to all this is that the words of the inflexible sentence designating the condemned books are "Libri omnes qui affirmant telluris motum." See Bertrand, p. 59. As to the idea that "Galileo was punished, not for his opinion, but for basing it on Script-

Catholics themselves. In 1870 a Roman Catholic clergyman in England, the Rev. Mr. Roberts, evidently thinking that the time had come to tell the truth, published a book entitled The Pontifical Decrees against the Earth's Movement. In this were exhibited the incontrovertible evidences that the papacy had committed itself and its infallibility fully against the movement of the earth. The Rev. Mr. Roberts showed from the original record that Pope Paul V, in 1616, had presided over the tribunal condemning the doctrine of the earth's movement, and ordering Galileo to give up the opinion. He showed that Pope Urban VIII, in 1633, pressed on, directed, and promulgated the final condemnation, making himself in all these ways responsible for it. And, finally, he showed that Pope Alexander VII, in 1664, by his bull,—Speculatores domus Israel,—attached to the Index, condemning "all books which affirm the motion of the earth," had absolutely pledged the papal infallibility against the earth's movement. He also confessed that under the rules laid down by the highest authorities in the Church, and especially by Sixtus V and Pius IX, there was no escape from this conclusion.

Various theologians attempted to evade the force of the argument. Some, like Dr. Ward and Bouix, took refuge in verbal niceties; some, like Dr. Jeremiah Murphy, comforted themselves with declamation. The only result was, that in 1885 came another edition of the Rev. Mr. Roberts's work, even more cogent than the first; and, besides this, an essay by that eminent Catholic, St. George Mivart, acknowledging the Rev. Mr. Roberts's position to be impregnable, and declaring virtually that the Almighty allowed Pope and Church to fall into complete error regarding the Copernican theory, in order to teach them that science lies outside their province, and that the true priesthood of scientific truth rests with scientific investigators alone.*

In spite, then, of all casuistry and special pleading, this sturdy honesty ended the controversy among Catholics themselves, so far as fair-minded men are concerned.

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ure," the answer may be found in the Roman Index of 1704, in which are noted for condemnation "Libri omnes docentes mobilitatem terræ et immobilitatem solis." For the way in which, when it was found convenient in argument, Church apologists insisted that it *was* "the Supreme Chief of the Church by a pontifical decree and not certain cardinals" who condemned Galileo and his doctrine, see Father Lecazre's letter to Gassendi, in Flammarion, Pluralité des Mondes, p. 427, and Urban VIII's own declarations as given by Martin. For the way in which, when necessary, Church apologists asserted the very contrary of this, declaring that "it was issued in a doctrinal decree of the Congregation of the Index, and *not* as the Holy Father's teaching," see Dublin Review, September, 1865.

* For this crushing answer, and by two eminent Roman Catholics, to the sophistries cited—an answer which does infinitely more credit to the older Church than all the perverted ingenuity used in concealing the truth or breaking the force of it—see Roberts and St. George Mivart, as already cited.

In recalling it at this day there stand out from its later phases two efforts at compromise especially instructive, as showing the embarrassment of militant theology in the nineteenth century.

The first of these was made by John Henry Newman in the days when he was hovering between the Anglican and Roman Churches. In one of his sermons before the University of Oxford he spoke as follows:

"Scripture says that the sun moves and the earth is stationary, and science that the earth moves and the sun is comparatively at rest. How can we determine which of these opposite statements is the very truth till we know what motion is? If our idea of motion is but an accidental result of our present senses, neither proposition is true and both are true: neither true philosophically; both true for certain practical purposes in the system in which they are respectively found."

In all anti-theological literature there is no utterance more hopelessly skeptical. And for what were the youth of Oxford led into such bottomless depths of disbelief as to any real existence of truth or any real foundation for it? Simply to save an outworn system of interpretation into which the gifted preacher happened to be born.

The other utterance was suggested by De Bonald and developed in the Dublin Review, as is understood, by one of Newman's associates. This argument was nothing less than an attempt to retreat under the charge of deception against the Almighty himself. It is as follows: "But it may well be doubted whether the Church did retard the progress of scientific truth. What retarded it was the circumstance that God has thought fit to express many texts of Scripture in words which have every appearance of denying the earth's motion. But it is God who did this, not the Church; and, moreover, since he saw fit so to act as to retard the progress of scientific truth, it would be little to her discredit, even if it were true, that she had followed his example."

This argument, like Mr. Gosse's famous attempt to reconcile geology to Genesis—by supposing that for some inscrutable purpose God deliberately deceived the thinking world by giving to the earth all the appearances of development through long periods of time, while really creating it in six days, each of an evening and a morning—seems only to have awakened the amazed pity of thinking men. This, like the argument of Newman, was the last desperate effort of Anglican and Roman divines to save something from the wreckage of theology.*

* For the quotation from Newman, see his Sermons on the Theory of Religious Belief, sermon xiv, cited by Bishop Goodwin in Contemporary Review for January, 1892. For the attempt to take the blame off the shoulders of both Pope and cardinals, and place it upon the Almighty, see the article above cited, in the Dublin Review, September, 1865, p. 419,

All these well-meaning defenders of the faith have but wrought into the hearts of great numbers of thinking men the idea that there is a necessary antagonism between science and religion. Like the landsman who lashes himself to the anchor of the sinking ship, they have attached Christianity by the strongest cords of logic which they could spin to these mistaken ideas in science, and, could they have had their way, the advance of knowledge would have ingulfed both together.

On the other hand, what has science done for religion? Simply this: Copernicus, escaping persecution only by death; Giordano Bruno, burned alive as a monster of impiety; Galileo, imprisoned and humiliated as the worst of misbelievers; Kepler, hunted alike by Protestant and Catholic—gave to religion new foundations, new and more ennobling conceptions.

Under the old system, that princely astronomer, Alphonso of Castile, seeing the inadequacy of the Ptolemaic theory, yet knowing no other, startled Europe with the blasphemy that, if he had been present at creation, he could have suggested a better order of the heavenly bodies. Under the new system, Kepler, filled with a religious spirit, exclaimed, "I do think the thoughts of God." The difference in religious spirit between these two men marks the conquest made in this long struggle by Science for Religion.*

Nothing is more unjust than to cast especial blame for all this resistance to science upon the Roman Church. The Protestant Church, though rarely able to be so severe, has been more blameworthy. The persecution of Galileo and his compeers by the older Church was mainly at the beginning of the seventeenth century; the persecution of Robertson Smith, and Winchell, and Woodrow, and Toy, and the young professors at Beyrout, by various Protestant authorities, was near the end of the nineteenth century. Those earlier persecutions by Catholicism were strictly in accordance with principles held at that time by all religionists, Catholic and Protestant, throughout the world; these later persecutions by Protestants were in defiance of principles which all Christendom to-day holds or pretends to hold, and none make louder claim to hold them than the very sects which persecuted these eminent Christian men of our day, whose crime was that they were intelligent enough to accept the science of their time, and honest enough to acknowledge it.

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and July, 1871, pp. 157 *et seq.* For a good summary of the various attempts, and for replies to them in a spirit of judicial fairness, see Th. Martin, Vie de Galilée, though there is some special pleading to save the infallibility of Pope and Church. The bibliography at the close is very valuable. For details of Mr. Gosse's theory, as developed in his Omphalos, see my chapter on Geology.

* As a pendant to this ejaculation of Kepler may be cited the words of Linnæus: "Deum omnipotentem a tergo transeuntem vidi et obstupui."

Nor can Protestantism rightly taunt Catholicism for excluding knowledge of astronomical truths from European Catholic universities in the seventeenth and eighteenth centuries, while real knowledge of geological and biological and anthropological truth is denied or pitifully diluted in so many American Protestant colleges and universities in the nineteenth century.

Nor has Protestantism the right to point with scorn to the Catholic "Index," and call attention to the fact that nearly every really important book in the last three centuries has been forbidden by it, so long as young men in so many American Protestant universities and colleges, and university extension schemes, and "approved courses of reading," are filled with "ecclesiastical pap" rather than with real thought, and directed to the works of "solemnly constituted impostors," while they are studiously kept away from such leaders in modern thought as Darwin, Spencer, Huxley, Draper, and Lecky.

It may indeed be justly claimed by Protestantism that some of the former strongholds of her bigotry have become liberalized; but, on the other hand, Catholicism can point to the fact that Pope Leo XIII, now happily reigning, has made a noble change as regards open dealing with documents. The days of Monsignor Marini, it may be hoped, are gone. The Vatican Library, with its masses of historical material, has been thrown open to Protestant and Catholic scholars alike, and this privilege has been freely used by men representing all shades of religious thought.

As to the older errors, the whole civilized world was at fault—Protestant as well as Catholic. It was not the fault of religion; it was the fault of that short-sighted linking of theological dogmas to scriptural texts which, in utter defiance of the words and works of the Blessed Founder of Christianity, narrow-minded, loud-voiced men are ever prone to substitute for religion. Justly is it said by one of the most eminent among contemporary Anglican divines that "it is because they have mistaken the dawn for a conflagration that theologians have so often been foes of light." *

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* For an exceedingly striking statement, by a Roman Catholic historian of genius, as to the *popular* demand for persecution and the pressure of the lower strata in ecclesiastical organizations for cruel measures, see Balmès's Le Protestantisme comparé au Catholicisme, etc., fourth edition, Paris, 1855, vol. ii. Archbishop Spaulding has something of the same sort in his Miscellanies. L'Epinois, Galilée, pp. 22 *et seq.*, stretches this as far as possible to save the reputation of the Church in the Galileo matter. As to the various branches of the Protestant Church in England and the United States, it is a matter of notoriety that the smug, well-to-do laymen, whether elders, deacons, or vestrymen, are, as a rule, far more prone to heresy-hunting than are their better-educated pastors. As to the cases of Messrs. Winchell, Woodrow, Toy, and the professors at Beyrout, with details, see the chapter in this series on The Fall of Man and Anthropology. Among Protestant historians who have been recently allowed full and free examination of the treasures in the Vatican Library, and even those involving questions between Catholicism and Protestant-

FIRST ACTIONS OF WOUNDED SOLDIERS.

By GEORGE L. KILMER.

AFTER observing for thirty years the questions of the curious on the subject of battle-field experiences, I should say that nine times out of ten the one first asked by a layman, old or young, relates to the sensations of a soldier when wounded. Even though the questioner has been maimed in a railway smash-up, or torn or fractured or bruised in some peaceful and therefore safe (?) occupation, the interest is the same, on the supposition, doubtless, that to be hurt by one of the engines of destruction in war is productive of unique sensations.

First of all, generalizations will not cover this intricate and expansive subject. An infantry soldier at Gaines's Mill, who was hit in the knee by a bullet and ultimately died of the wound, said that he thought he had run against a standing thistle; and the fact that he marched on, until his comrades drew his attention to blood flowing down his leg, indicates that he did not make too light of the first sensation. An officer, whose ankle was shattered by a bullet as he stood upon a pile of fence-rails to reconnoitre, thought that a rail had turned under his weight and sprained the joint. He felt only a slight burning sensation, although the wound proved a mortal one in the end. On the other hand, a strapping, coarse-grained fellow, whom I knew well, and often remarked making light of the very idea of pain and suffering, quickly collapsed under a wound that he survived. And well he might. He was hit by a section of mortar-shell weighing three or four pounds that cut edgewise through his thigh, bone and all. He happened to be resting with his thighs across a small log that served as a block to the jagged cleaver. I was looking into his face, about to speak to him, at the very moment the missile struck, and, despite his callous fiber and almost brutal stoicism, he winced as though he felt—exactly as a human being might be supposed to feel under such a blow—all "broken up" by the calamity.

Wounds that almost kill on the spot seem to be the least felt at the outset. Slight ones often produce enough disturbance to suggest the work of a dozen death-hurts. A spent missile that only raises a lump will make the victim feel as though an arsenal full of balls had struck him; and often soldiers with ghastly mor-

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ism, are Von Sybel, of Berlin, and Philip Schaff, of New York. And it should be added that the latter went with commendatory letters from eminent prelates of the Catholic Church in Europe and America. For the closing citation, see Canon Farrar, History of Interpretation, p. 432.

tal wounds insist that nothing serious is the matter, and act up to the idea until death or nervous exhaustion lays them low.

This much, however, may be said in a general way: When felt at all, bullets through the flesh usually produce a burning sensation more or less acute. When bones are broken, stinging accompanies the burning. When bones are hit but not broken, there is a numbing sensation in the whole region involved in the shock, followed very soon by severe and sometimes intense pain. When muscles and tendons are involved, there is a tugging sensation, sometimes very slight, and shell-wounds produce feelings similar to those by bullets, more or less exaggerated, according to the size of the missile and the degree of velocity. Bayonet-wounds I never saw except upon corpses—for I was not a hospital attendant—and as for cannon-balls, they do not, as a rule, leave anything behind to exhibit feelings.*

Again, a soldier may receive two or even more hits so close together as to produce counter-sensations. I once saw my commanding officer prostrated by a piece of shell that shattered his thigh-bone. While he was falling, pieces of another shell hit him in the arm and hand, and a piece of a third shell quickly following grazed the crown of his head. He has always believed that he felt three ways at once during those few seconds, and he is very positive that he felt badly hurt, and cordially wished to be out of it.

Not infrequently, too, when a victim has been spared the smallest amount of vitality after the impulse of anger is cut short by a slashing wound, he feels very much as did an enthusiastic tar upon a trying occasion. In an affair now memorable in history, a certain war-vessel's crew was compelled by the etiquette of the service to stand by and see their country's flag hauled down in contempt, without being given a chance to strike in its defense. "It was the saddest hour of my whole life," said one of them, "and for quite a spell I alternated between a desire either to cry like a baby or swear like a pirate."

All this preliminary to a paper the scope of which is only partially suggested by the title. Poets and orators, who take a wholly sentimental point of view, ask the world to accept the notion that it is a glorious fortune for the individual man to suffer punishment in honorable warfare; but between the wound and the sequence, whether death or the hospital and the scalpel,

* Experts affirm that a cannon-ball having velocity to keep it in the air will make a clean cut of flesh, bones, and ligaments, and not simply tear them, or push them aside as with a punch; and that a ball slowing up and rolling along the ground at the rate at which a man moves in rapid walking will crush the bones of a foot or leg that resists it. In the civil war spherical and elongated shells usually served the stead of solid cannon-balls.

what are the symptoms, what the actions, above all, what the conscious feelings of the victim himself, or, as poetical fancy insists he shall be named, the hero? How wide or how narrow to his vision is the interval between the hard reality and the sentimental ideal? Flesh and bone of themselves can not be expected to rise to the height of the strained occasion. Torn and broken, glory never heals the one or sets the other; and so men's bodies will not forever remain insensible to the claims of Nature, even though in the excitement of war the mind may be superior to every consideration less than heroic. Yes, there must be a time when the will of the soldier is at odds with the forces that normally rule the sinews and tendons of his frame—a time, dear poet, when the hero proves to be only a man—a creature inspired after the flesh as well as after the spirit.

And now, looking at the soldier as a warring machine, does a missile fired into the delicate apparatus bring the whole engine quickly to a dead halt? The world hears so much about the Light Brigade at Balaklava that it should be familiar with the tragic story of the most noted victim of that affair, Captain Nolan. Nolan, as aide-de-camp of the division general, assumed to guide the Light Brigade in its awful charge, and, with frantic exclamation and vehement gestures with his uplifted sword, he rode to the right oblique beyond the head of the reckless column, in order to draw the six hundred out of the valley of death, which lay directly in their course, off toward a line of flanking redoubts which they had been ordered to attack, and where victory and not disaster doubtless awaited them. When he was a few paces to the right of the leading ranks a piece of shell struck him on the chest, tearing into the heart.

"The sword dropped from his hand," says the minute chronicle of Kinglake, "but the arm with which he was waving it the moment before still remained high uplifted in the air, and the grip of the practiced horseman, remaining as yet unrelaxed, still held him firm in his saddle. Missing the perfect hand of his master, and finding the accustomed governance now succeeded by the dangling reins, the horse all at once wheeled about and began to gallop back upon the front of the advancing brigade. Then, from what had been Nolan—and his form was still erect in the saddle, his sword-arm still high in the air—there burst forth a cry so strange and appalling that the hearer who rode nearest him called it unearthly. And in truth, I imagine," continues the historian, "the sound resulted from no human will, but rather from those spasmodic forces which may act upon the bodily frame when life as a power has ceased. The firm-seated rider, with arm uplifted and stiff, could hardly be ranked with the living. The shriek men heard rending the air was scarce

other than the shriek of a corpse. The dead horseman rode on till he passed through the interval of the Twelfth Light Dragoons. Then at last he dropped out of the saddle."

The line between Nolan living and Nolan dead was very narrow, yet the uplifted arm* and the battle-shout ending in an unearthly yell would indicate that the soul of the warrior dominated every element of activity so long as any activity remained. Had Nolan been trotting along in the ranks of the six hundred with no other thought than that of keeping in line and getting ahead, he would doubtless have gone to the ground like a bolt under that blow.

An experience of the same nature, but at the other extreme, was that of General Joseph Hooker at Antietam. On the morning of the 17th of September, being in the presence of the enemy with his corps, he began a movement to seize high ground on his front, and was compelled to pass lengthwise of the Confederate line within range of hostile batteries. Soon a strong body of the enemy showed itself in his pathway, and in the excitement of making new dispositions, and routing and pursuing the Confederates, the general, to use his own language, "was lifted to the skies." "The whole morning has been one of unusual animation with me," he wrote also. Yet at the end of the successful attack he was removed from his saddle just as he was in the act of falling from it, weakened by the loss of blood from a wound of which he had not been conscious at all. A musket-ball had passed directly through the foot between the arch and the muscles of the sole, the seat, as every one knows, of very sensitive nerves. Had the general been in a state of moderate repose, as, for instance, quietly watching the execution of some movement, the blow would have unmanned him, for the moment at least. Intensely preoccupied as he was—and he had good reason to be, at that stage of the battle—he did not notice the blow or the sensations that accompanied and followed it. He may have carried the wound an hour or more before succumbing to the faintness.

My attention was first drawn to this subject by a strange personal experience—suspended animation in the body combined with partial mental clearness. The facts were of a kind that could be recorded with accuracy, and I am able to state them in detail. We were in front of the enemy at Fredericksburg Heights, May 3, 1863, and were lying under the shelter of a low ridge, expecting to charge or to repel a charge. The term of service of our regiment would expire the day following, and the troops

* External pressure—the weight of the sword and the pulling of the horse at the bit—would cause relaxation of grip in both sword and bridle hand, and collapse of the chest-walls the strange expiratory cry.

be sent home to disband, and with others I speculated not a little on the chances of escape in the impending fight. There had been times in my career as a soldier when I was "too anxious for wounds and scars," as General Grant once remarked of Ned Buntline, and even at the eleventh hour, with the prospect, as I believed, of a speedy return home, I consoled myself with the thought that if wounded I would carry a glorious badge on the homeward march. But I went into action that day, convinced on the whole, that the fellows across the line would not pay special attention to me, for I held that I was an indifferent mark for good ammunition—a lad of seventeen years, small inches, and light weight.

It turned out that our position, though supposed to be well sheltered, was closely inspected by a number of Confederate sharpshooters, but, as it was very important that we remain at that point, we had to make the best of it. I was near the head of the line of the regiment, and, as we lay strung along on the slope of the ridge, I could see every man in the command. One after another the sharpshooters' bullets began to tell. I noticed a lieutenant in one of the companies moving about on some official errand and making a splendid target, and, while I was thinking how cool he was, something struck him and twisted his body around so that I detected the break in his locomotion. He did not halt, but went on calmly and freely for some paces, and in a few minutes, having delivered some orders and exchanged words with some of his men, he went to the rear with a decided limp. Between the moment of his wounding and the accomplishment of his purpose he did not limp at all, and probably did not know that he was hit (it was a flesh-wound in the thigh) until told of it. Then, when he knew what had happened, he yielded to new mental processes and acted as wounded men are supposed to do. When the lieutenant had disappeared from view, I turned my face to the front, bolstering my trembling hopes with the thought that this last victim was a shining mark, as I certainly was not. Besides, I believed that the sharpshooters could not get the range on our end of the line. Then followed a "thud" close to me, and my next sensation was that I was prostrate on the ground, pierced through my left arm, heart, and spine with a rod, and pinned to the earth. This was the physical sensation, but, of course, was not the fact. Then through my brain there flitted quickly a vision such as the thought of a battle most commonly brings to mind—masses of warring men struggling individually for the mastery. I seemed to be in the midst of the *mêlée*, and with all the indignation I could express was shouting to the men in gray, "There, you have hit me!" Next I was being lifted and supported by some one, and a voice said, "He isn't hit, but something is the

matter." "Yes," said another voice sternly, "he is hit, and as good as dead. Take him to the rear." I had so far recovered as to comprehend these remarks, and instantly concluded that I was the subject of a practical joke. In another moment I was seized with the keenest pain I have ever experienced in my life, in the region where it had seemed in my swoon that I was run through with a rod. Now, what had happened was this: I had been in a sitting posture, resting partly on the ground, partly upon my legs doubled beneath me, the left hand holding my weapon, the arm well braced across my chest so that the middle of the upper bone pressed against the heart. On my arm were two shirt sleeves, a jacket sleeve, an overcoat sleeve, and the overcoat cape; and a musket-ball moving in the direction of my heart and spine—that is, obliquely to the front of my person—had ticked the limb of a bush a few feet away, keeled over, and struck flatwise on the arm, imbedding itself in the flannel and the flesh. The bone, protected by the clothing, had been the resistant, and the shock, carried to the heart and spine, had rendered my body senseless for a time; but the brain, depleted by the sudden stoppage of circulation, had been abnormally active. The man who exclaimed that I was as good as dead had reason to think so. He was on the slope above, and was looking at me at the time. He heard the bullet, and saw me go down under it "like an ox hit on the head with an axe," as he expressed it. He also said that my face changed colors rapidly from ghastly white to deep purple, and that I lay on the ground so still that he believed for the moment that I was dead. It is evident that the fancies of the brain immediately following the wound were closely connected with the previous thoughts, for the burden of them was surprise and disappointment that, after all, I had been hit. It was somewhat singular that in my delirium I located my hurt correctly, and had the physical sensation of being pinned to the earth by a rod running through the very spot where the shock of the blow was keenest.*

An experience, similar in many respects, befell one of my companions in arms, Captain W. R. Helms, (Fourteenth New York Heavy Artillery, and Sixteenth New York Volunteers) at the battle of Gaines's Mill. Helms was a lieutenant at the time, and while the regiment was charging to recapture a battery that the Confederates had just taken and were about to open upon its late owners he was hit and went down. He heard his captain give the command, "Take his body to the rear," and saw men leave the ranks

* Statistics on this point have not been widely gathered, but numerous instances have been noted where severely wounded men who retained consciousness did not know the location of the hurt until sight or touch revealed it. Physiology accounts for the phenomenon in many ways. In my case an unusual area of skin and bone surface received pressure and the sensations were unusually strong.

to respond. He thought that his head only was lifted from the ground, and tried to speak, but could not. He recognized a fellow-officer who passed at the moment, and remarked upon the accident. Then he concluded that the battery had been fired, and that his head had been shot off. This puzzled him, and he began to speculate upon the phenomenon of a head carrying on reasoning processes while separated from the body. Was it not a mistake, after all, to believe that the soul is located in the body? Was not the experience he was passing through proof that the seat of all consciousness, will, and reason, and every spiritual attribute was in the head? (Helms was orthodox, and a remark from a skeptical physician, some time before, to the effect that dissection revealed no such an organ as the soul, had left a strong impression upon his young mind. He was yet in his teens.) Metaphysical thoughts were at length interrupted by a pricking and stinging sensation in the neck, and gradually full consciousness and motor power returned. He had been lifted and carried out of the reach of balls, head and all intact. A bullet had hit the leather straps of his haversack and canteen where they crossed his shoulders, cutting two and stopping at the third, as they lay close to the neck. (The flying ends of the severed straps caught his eye the moment it was done.) The collar-bone was broken, and the large muscles and tendons of the neck were badly bruised. Evidently there was temporary paralysis caused by injury of certain nerves at the neck, with but slight derangement of the functions of the organs in the head, while the sensory functions of the body were cut off from participation in sensations registered at the brain.*

In contrast with Captain Helms's counterfeit is a case of actual decapitation, noted vividly and vividly recalled by comrades of my regiment, particularly by one who was a careful and sensitive observer, Captain A. H. De Graff, now an engineering expert. On the 17th of June, in the charge of the Ninth Corps on the Confederate works east of Petersburg, a sergeant of the Fifty-seventh Massachusetts leaped upon the parapet, and, with his cap in his left hand and his musket in his right, stood cheering and gesturing with his arms to incite his comrades to come on. Suddenly a shell took his head off as completely as a knife could have done, but the tall form continued erect for some seconds, the arms still waving frantically, but with ever-lessening sweep and power, until the forces of the body collapsed, when the headless trunk toppled over to the ground.†

* Physiology assumes that complete separation may take place at the neck and the functions of the divided parts go on for a space. A head freshly guillotined gave back mocking gestures of the mouth and eyes when a bystander made faces at it.

† A swift bullet will pass through a pane of glass and not jar it enough to crack it. The shell did its work without upsetting the body by the force of the blow. Dr. S. G.

Virtual subordination of the physical or material senses to the nervous centers controlling the intellectual or spiritual faculties, and for an appreciable length of time, seems to be quite common in wounded men, even in the severest cases. It is easily conceivable that a thoroughly mad man might ignore an ordinary wound until his anger cooled a little; but that men wounded to the death should, even while actually dying, persist in their purposes as though nothing had happened, at first staggers belief. Yet such things do unquestionably occur. Every veteran of the field will recall instances, and history in one way or another records a great many. In the attack on the Ninth Corps lines at Petersburg, known as the battle of Fort Steadman, I noticed a mounted Confederate officer leading a body of men in a charge upon a cannon near which I stood. The last view I had of him—and that was across the sight of a Springfield rifle—showed him riding boldly forward, sword on high. Others saw him later and nearer, and his fearless action in riding a white horse under a storm of bullets, grape, and shells attracted much notice. Suddenly man and horse disappeared, and after the fight we found the bold rider lying dead about sixty to eighty yards from our parapet.* His form was prostrate, his sword-arm outstretched and grasping the weapon firmly, with its point toward the cannon he had aimed to capture. His face was partially upturned, as though he had struggled at the very last to see something or to speak. The horse had wheeled about and gone to the rear some distance, then had leaped at a breastwork and fallen dead across it. Whether this was after his rider had been hit or before couldn't be determined. In any case the Georgia major breathed his last with his face to the foe, evidently warlike and defiant in death. His wound was in the head.

An instance similar to the last was that of General Elon J. Farnsworth, at Gettysburg. At a crisis in a charge, Farnsworth raised his saber and rode toward the ranks of the Fifteenth

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Cook, now President of the Board of Police Surgeons in New York city, witnessed a similar instance in the Atlanta campaign, where he served as surgeon in the One Hundred and Fiftieth New York Volunteers. The doctor, with other officers of the medical corps, was riding rapidly across the range of a Confederate battery, which was shelling a column on the march. Hearing a "thud" behind, as a shell passed near him, he turned around and to his amazement saw that one of his companions, Surgeon H. S. Potter, of the One Hundred and Fifth Illinois, had been decapitated, and his horse was galloping on with a headless rider sitting perfectly erect and natural in the saddle. With a little steadying the body remained upright until shelter was reached, the pace being all the while a gallop.

* From conversation with the late Henry W. Grady, respecting his father, who lost his life in this attack, I believe this officer to have been Major Grady, of Georgia. I did not shoot him. After drawing bead on him perhaps half a dozen times, admiration for his unexampled daring got the better of me, and I lowered the weapon with the exclamation, "He is too brave—I can't do it."

Alabama Infantry, meeting a volley of balls. Shortly afterward his riderless horse dashed through the regimental lines. The general had fallen, with five mortal wounds, and when found still clutched his outstretched saber, and bore the appearance of having been unhorsed when dead or dying, much as in the case of Captain Nolan.

In the excitement of such actions as those where the Georgia major and Farnsworth fell, it is not possible for any observer to note the symptoms minutely. The fact that a man is down and out of the fight is about all that friend or foe can take account of for the time being. It is reasonable to suppose, however, that some deaths are instantaneous, the men being literally killed in action. One such case I had an opportunity to study with unusual care at Fort Haskell, in the Fort Steadman battle at Petersburg. The action there was defensive on our part, the scene very small, and the fight prolonged, hence many things were observed that would escape notice on an open field. At one time, just in front of me as I looked toward the enemy, there was a soldier of our garrison firing his musket from a gun-staging that raised his head and shoulders above the parapet. He was the oldest man I ever saw in battle, and for that reason doubtless I observed him closely. His hair was white, and his form had reached the stage of unsteadiness. He fired very slowly, and after each shot would scan the enemy's lines, as though watching the results of his last ball or spying out a target for the next. Finally, when I had my attention almost wholly on him, he half turned to reload, and I saw his cap fly off smartly without any visible help, and the large and bony frame shrink together and sink down into a heap. There was no spasm, no agitation whatever. It seemed to me that he simply sat down slowly until he rested on his legs, bent under the body, his head going down to his knee, or to the trail of the cannon. A little stream of blood ran from his forehead and made a pool on the plank, and this blood reached the plank about the time that his frame settled itself down motionless. From the time that his cap flew off until the blood appeared on the staging, and the motionless body led me to say, "He is dead," could not have been more than thirty seconds, and was probably about twenty. The fatal ball had penetrated the left temple or near it. This was the only case where I noted all the external manifestations of a soldier killed "so quickly that he never knew what hit him," as the saying is.

All that are found dead on the battle-field figure in the lists as "killed in action." Of these quite a percentage may meet with instantaneous death, but the majority show proof that both body and mind were at work after the fatal blow was received. One of the most convincing cases of the kind, and at the same

time the most terrible, that came to my personal knowledge was at Antietam, where General Hooker conducted the fight when he received his wound. The Confederates were massed in a field of tall corn, and Hooker ordered his batteries to open on them with canister. In his report he says that the shot cut every stalk of corn in the greater part of the field close to the ground as neatly as though done with a knife. Of course, the men in that field did not escape the biting hail. Neither did they stand like lambs and accept their doom. After the first cannon volley the survivors started toward Hooker's batteries, mounting a rail fence that barred their progress, and just in front of and along this fence several hundred lay dead after the action. The regiment in which I served took position at one end of the fence some hours afterward, and as this field was between the lines the bodies had not been disturbed. About sundown there was a sort of truce to remove some of the wounded, and with others I passed along the fence to see the line of the dead. Some of the poor fellows had passed over the fence and begun creeping forward, gun in hand; some had gained the top of the fence, and death had left them balancing across the rails; others, in the act of climbing, had died leaning against it or dangling from it head foremost, having passed partly over and been caught by the feet. Generally the sword or musket was held in firm grip, the eyeballs turned forward, and every muscle and organ bearing evidence of having been strained to get at the batteries that were making such dreadful havoc. When I returned to the end of the line and glanced back again at the prostrate column, I said to my comrades who had not gone out to get a close view: "Boys, it is just as it looks from here. Those men were caught at it, and were struck down in the act." It is not to be wondered at that General Hooker was too much absorbed at the time of this fighting to notice his wound. He wrote of the action that the "slain (Confederate) lay in rows precisely as they had stood in the ranks a few moments before." *

Very, very few of these dead bore the look of having passed away composedly. Yet, on the ordinary battle-field, where the killed outright number but two or three to every hundred of combatants, the exceptions are those who do not die in a quiet state of mind or body. Men who are cut down in a charge, while the tide of heated action sweeps on, leaving them alone, bend their thoughts at once to themselves, and, if death is felt approaching, turn their faces up to the quiet skies, compose their

* The scene here described was visible from two o'clock P. M. until sundown from the northern edge of the East Wood along the fence running from the East Wood westerly to the Sharpsburg pike, and separating a corn-field from the elevated cleared field lying south of the Miller farmstead.

souls, and so breathe their last. It will be only in some such struggle as at Antietam, or before the stone wall at Fredericksburg, or in Pickett's charge at Gettysburg, and the front line at that, that men will die retaining full intensity of battle ardor so long as breath holds out. There we may expect to find men dead with their weapons poised and their colors held firm in the death-grip.*

The manner in which men fall depends also upon the nature of the action in which they are engaged. Nearly every one is familiar with the traditional stage fall, where the victim of a supposed death-shot strikes an attitude, clasps his hand to his heart, stiffens every joint and muscle, breathes hysterically, and goes down like a log toppled over from the end. Another popular yet erroneous notion is that men shot through the vitals leap into the air and go down in a dramatic attitude. Sometimes men are found on the field in striking positions, but often an examination shows that the position was taken after the fall. As a rule, a man who is hit above the hips goes down.† The slighter the wound the more commotion, for the body instinctively resists, just as it does when one slips or is pushed or collides with some object. But a wound in a vital spot weakens the resistance, and men sink at once, or reel and tumble with very little self-control. One reason why men are found dead in a variety of positions is that so long as consciousness remains they strive to help themselves. The wound and the fall together create a temporary panic. Any one who knows the sensation of being temporarily arrested, when at a high rate of speed, by some accident, may imagine the general state of mind of a soldier when hit in action. Something has happened; he is the victim; how serious is it? A man's first thought is of the rear of the column, and this not from fear, but because he expects surgical aid from that direction. So long as he can move he goes toward the place of help. When no longer able to move he makes himself as comfortable as he can and waits. In this waiting many die, and it is a question whether many do not die from over-anxiety—that is, add to their hurt by fretting and struggling. There are soldiers of the civil war living to-day who received wounds as serious at the time as some who died on the field. Either their temperaments were more hopeful or their circumstances more favorable.

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* Physiological science recognizes, and in a measure accounts for, *rigor mortis* in cases of the kind cited.

† There is an apparent, but, I think, not a real contradiction of this statement in the statistics collected by Dr. S. Weir Mitchell, in the United States Army Hospital at Philadelphia, during the war. Out of fifty-six wounds involving the arm system of nerves, twenty-seven fell. But he had excluded all cases accompanied by "early and severe hæmorrhage," and was not considering the dead and mortally wounded, nor those cases too severe for long-distance transportation.

Returning to the question of persistent aggressiveness in severely wounded men, two instances remarkable in a special way are worthy of note. There was no warlike anger, but simply sudden excitement, for a cause. In one instance two soldiers were practicing at bayonet exercise and became very much warmed up, as men do in a boxing match. Finally, when one of them made a lunge at the breast of the other, the muzzle was knocked down slightly by the opposing piece and a discharge followed, the bullet going through the groin. With this frightful wound, given at a couple of feet at most, the unfortunate victim kept a tight grip on his piece, staggered forward, and made fitful lunges at his opponent, who dropped his gun and ran, terrified by the unearthly stare and grimace and the frenzied actions of the other. It was supposed that the balls had been drawn, and the man whose piece went off did not know at once that the charge was fatal. The injured man gave chase for a few paces and then fell dead.* A case where there was even less external incitement to extraordinary endurance is recorded by Captain J. F. J. Caldwell, in a history of Gregg and McGowan's South Carolina Brigade. During the engagement at Sutherland's Station, below Petersburg, April 22, 1865, Captain Caldwell, while riding over the field on staff duty, met two Union soldiers who had broken through the Confederate lines with a charging column that had been repulsed, and become separated from their comrades. Resistance was useless, and they dropped their guns and followed the captain toward the Confederate rear. One of the prisoners lagged on the march, and, on being told to step lively, he held up one arm and showed such a bloody and distressing wound that the captain allowed him his own gait. All the time both prisoners chatted briskly about the Union tactics, and boasted that the tables would soon be turned upon the Confederates. When the party came to a fence the wounded man helped to let down rails for the captain's horse, and in every way showed good spirits and fair condition. At the first medical bivouac Captain Caldwell turned his charge over to a surgeon, who found a second wound in the patient's breast, and in a few minutes after halting death ended his captivity. The man had borne up under a mortal wound, with the spur of personal enthusiasm and expectation. He had hoped for a recapture by the advance of the Union lines.

The conduct of wounded men after an interval I do not purpose to describe. So soon as the mind gets settled down to the

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* Paré, the French surgeon, recorded the case of a duelist who received a sword-thrust through the heart, large enough to admit a finger, and who followed up his fleeing antagonist, thrusting repeatedly, for two hundred yards before he fell.

new order of things, individual temperament resumes entire control. The phenomena of severely wounded soldiers continuing in action is correctly ascribed to abnormal mental excitement. Analogies are seen in every-day life. Contusions, incisions, and even fractures are sustained during excitement and no immediate impression is carried to the intellect. Yet how keen the suffering experienced under slighter hurts made by the surgeon's scalpel, forceps, or drill, when all is known beforehand! A soldier's life predisposes to intensity in either direction. He will stoically ignore or morbidly welcome injury. His mind, first of all, is made up not to notice danger or to be unmanned by wounds. So long as he can keep in action—that is, so long as he may personally direct some expenditure of muscular energy—his stoical purpose will hold out. As a matter of course, when he changes from a personality to a mere machine, manipulated by higher minds, fighting when told to, and again standing or lying still to receive blows and injuries with no chance to retaliate, he changes from a Stoic to a morbidly sensitive being. Familiar with deep and distressing injuries to others, in hugging the hope that he will be spared the worst, he invites fears for the worst at the moment he receives a blow, and fears strike the mind as soon as the bullet hits the body. This may account for frequent aberrations of conduct that follow ordinary wounds. The bravest may be unmanned by them, and doubtless death-fright actually takes place with gallant souls; or, if neither death nor delirium follow, then extravagant notions of pain, and violent wailing over trifles.

Numberless cases might be cited showing that excellent soldiers are thrown into sudden mental and physical panic by war wounds, just as civilians are by injuries and surgical operations. Exaggerated sensations of suffering and often quick delirium are reported from the battle-field, such as can not be the direct and necessary sequence of the actual injury, but take rise in the emotions.

As a rule, reported war cases are confined almost wholly to injuries not necessarily fatal. Fatal ones rarely get on record, because the cool and observant surgeon does not study the symptoms of the actual field of fighting.* Of those who are struck insensible and subsequently revive and survive, there are known to be many; but of the number rendered insensible who revive and resume action and then die, there can only be conjecture. In this class must be placed many whose attitudes in death are abnormal. But taking into account the symptoms of the wounded who have lived to report them, and of the dead whose cases have

* In the civil war the proportion of deaths to the surviving injured was a trifle more than one to three.

been recorded by spectators, there is a general agreement that symptoms do not at all correspond in kind or severity to the injury.* Hence phenomena appearing at first thought remarkable may be accepted as not uncommon, considering the unrecorded instances.

I class as remarkable the cases of Nolan, Hooker, Farnsworth, the Georgia major, the beheaded sergeant, the wounded prisoner, and the man skylarking in bayonet practice, and will add that of General Albert Sidney Johnston, killed at Shiloh; and it is proper to state that this collection sprang originally from an effort to bring together the same order of phenomena without reference to antecedent causes. Further investigation proved that, of these cases, Nolan, Hooker, Farnsworth, the Georgia major, and Johnston certainly, and presumably the Massachusetts sergeant, had the highest order of emotional stimulation at work before closing into the heat of action.

It was Nolan's first chance in real war. He had served on routine headquarters duty until that day, and being sent to the front in a crisis, he galloped his horse down a rocky steep where no hoof had ever before trodden. On delivering an order to the division commander, words ensued as to its meaning, and Nolan's excitement was increased. When at last the Light Brigade started and went wrong, he kept the intended course alone, saying, with all the powers of voice and gesture he could command: "This way, this way! For Heaven's sake, not that way!" While so engaged he was hit in the most vital spot in the body, yet warlike action was persistent to an almost supranatural extent.

Hooker had just received command of a corps; there was rivalry between him and others; he was honored with the lead in the most important attack; the enemy's resistance was unexpectedly stubborn, the carnage frightful above all experience on any American battle-field, and on him rested the responsibility of success that would glorify the whole army and the nation.

Farnsworth, on being asked to lead a cavalry charge over a field strewed with bowlders and swept with cannon, demurred, and his chief said to him tauntingly, "If you will not lead your brigade in, I will." "Where my brigade goes, I will lead," was the answer, and he sounded the charge. He found a slaughter-pen as he had expected, was hemmed in, and with fifty followers started to cut his way through a double line of Confederate infantry.

* The small missiles which inflict the majority of war wounds strike fewer nerves of pain than do the instruments of injury in ordinary collisions, where large areas of skin surface are bruised or lacerated; their execution is also more rapid. The instantaneous collapse following violent symptoms of warlike vigor is also a peculiarity of battle-field life. Violent mental and muscular actions have swiftly depleted the reserve forces, and, where collapse would be slow under normal strains, it is swift in abnormal cases.

Possibly his five mortal hurts were received simultaneously, but probably he carried two or three of them while persisting in his fight.

The Georgia major had been selected or had volunteered to lead a forlorn hope upon which the salvation of an enterprise depended, and he was called upon to pass eighty rods under cross-fire of cannon and muskets. That feat he essayed, conspicuously mounted upon a white horse.

The attack in which the Massachusetts sergeant engaged was the third day of fierce and progressive onslaughts, and was directed against the last but one of Lee's interior lines around Petersburg. The stubbornness of the Confederate resistance had aroused the spirits of the assailants to the supremest pitch.

General A. S. Johnston at Shiloh was engaged in a campaign for the recovery of territory valuable to the Confederacy; he had been transferred from the East to supersede other generals; his fame was at stake; he had engaged upon one of the most daring and delicate enterprises known in warfare, a surprise of his enemy, to end in a wholesale slaughter or capture of the routed hosts on the banks of a bridgeless river. The movement carried well up to a point; there, a Union division showed what Johnston pronounced stubbornness; his men hesitated, and he went personally with one brigade in a charge; the charge succeeded, and he drew back to bring up another brigade, when a musket-ball severed an artery in his leg. He made no sign, but kept on giving orders and watching events until spectators saw that he was pale. He was asked if he was wounded, and, as if acknowledging it to himself for the first time, said: "Yes! And I fear seriously." He was then on the point of death from hæmorrhage.

Under normal conditions the symptoms in each of the cases in this recapitulation, except that of the headless man, should have been trembling, tottering, pallor, faintness, nausea, with expression of anxiety and distress, the whole frame being instinctively sympathetic with the injured part. But the several nerve-centers were not in a condition to perform normal functions. The mental excitement acting in the nature of a stimulant upon the center of the brain, monopolized the capacity for keen sensation, and centers that should have registered the hurt suspended their functions. So there was no concentrated shock, as ordinarily happens. The shock was distributed and showed itself, when finally potent, in an instantaneous collapse. This is the theory generally accepted by science—the theory of a law that two nerve-centers can not be excited at one and the same time. Is there not confirmation of it in the complicated case of the wounded prisoner reported by Captain Caldwell? The man doubtless suffered laceration in the arm and the cutting of an internal artery, by

the same ball in the order named. His arm-wound would register its shock first upon the intellect, and it would be of a kind that a soldier in his situation would speedily resolve to "grin and bear"; and the second, though mortal, would be overlooked, and suffered to do its quiet and fatal work. His first wound increased the existing excitement at the chief nerve-center, and aided to suspend the functions of the center most vitally involved in the wounding. The case of the beheaded man is again anomalous. Spasmodic action or discharge of the motor-forces stored in the nerve-centers of the trunk may have produced the phenomena.

Incidentally there arise from the consideration of the foregoing these two questions: First, could the expenditure of stored-up nerve force, either in sound or injured parts, or in both combined, generate all these erratic manifestations, or do impulses issue direct from the brain so long as life holds out? Second, is there a battle frenzy peculiar to certain natures, and in certain conditions to average men as well, that may lend them abnormal powers of nervous vigor and endurance? But, whatever the efficient cause, at least one compensating thought follows a study of these phenomena, and the poet and orator may extract some comfort from it, cold and speculative though it may appear. The soldier in war bears up under a severer hurt than the same man could endure in every-day life, and collapses under a lesser one than would ordinarily be required to disable him. He bears up longer and collapses more quickly. Therefore, the provision of Nature that renders him insensible of wounds in heated action may be a twofold blessing, in that it spares him pain and terror at the moment of his hurt, and while doing this service rapidly exhausts in his system those reserve forces which might otherwise tide him over the inevitable prostration succeeding wounds and warlike ardor, and embitter him with a sense of his vulnerability and weakness. How many noble fellows, missing the lethal stroke, have besought their comrades, their captors, and their medical officers to put them out of misery, annalists of the field would shudder to make known. So the hero's impulse, be it patriotism, fanaticism, or frenzy, in spurring him on, saves his high-strung soul from the rack of physical torture, and brings death in a moment of rapturous exaltation, weaving about his last deeds the halo of that glory which is the soldier's most coveted reward. Not alone soldiers, but men of action everywhere, long for a death that shall be but a pause—no, that could be perceptible—a lightning leap between a fiery fullness of being on earth and the dazzling dawn of new life beyond the veil.

THE YUCCA MOTH AND YUCCA POLLINATION.*

By C. V. RILEY, Ph. D.

THE common belief, based upon the theological assumption that all things upon this terrestrial sphere are for man's especial benefit, was, and perhaps yet is, that flowers were endowed with beauty and fragrance for our particular pleasure. Let us look somewhat more closely into this matter, and see what modern science has to say about it. Ever since Linnæus used the sexual characteristics of flowers in classification, and Erasmus Darwin sang of the loves of the plants, the philosophy of fertilization in the plant kingdom has been fairly apprehended. It has long been recognized that plants are divisible into homomorphic or self-fertilizable, and heteromorphic or cross-fertilizable species. All diclinous plants, or those having separate male and female flowers, belong to the latter category, which is further classifiable according to the means by which cross-fertilization is effected. One class (termed *anemophilæ*) depend almost entirely on the wind, and in these, of which our pines and other conifers, our poplars, willows, grasses, etc., are examples, the pollen or male element obtains in enormous quantities, is easily detached, and is generally produced early in spring, when winds prevail, and frequently before the development of the leaves, which would tend to impede its dispersion. The flower is inconspicuous and the stigma or female organ generally branched or hairy, so as to increase the chance of catching the wind-borne pollen. Water is an agency in the fertilization of a few plants, of which the singular Vallisneria is a striking illustration; while a few are aided by birds and higher animals; but by far the greater number are fertilized, or, more strictly speaking, pollinized, by insects.

The most casual observer of Nature must have appreciated, years ago, the fact that flowers are very important to insects, furnishing the essentials of life to those of several orders, and especially to the Hymenoptera (bees, wasps, etc.) and Lepidoptera (butterflies and moths) in the form either of pollen or nectar. But that insects could be of any especial benefit to plants has only come to be acknowledged and fully appreciated of late years. Toward the close of the last century Christian Konrad Sprengel published an important work—Das entdeckte Geheimniss der Natur—in which he maintained that the color, form, odor, secretions, and the general structure of flowers had reference to insects which are essential as pollinizers. The importance of insects as

* Adapted from advance sheets of the Annual Report of the Missouri Botanical Garden for 1891.

agents in cross-fertilization was scarcely appreciated, however, until the late Charles Darwin published the results of his researches on Primula, Linum, Lythrum, etc., and his elaborate work on the fertilization of orchids. The publication of these works gave to flowers a new significance and to their study almost as great an impulse as did his immortal Origin of Species to the general study of biology. Hooker, Bennett, Axell, Del-

FIG. 1.—FLOWER OF YUCCA ALOIFOLIA, showing stouter pistil and shorter style as compared with *filamentosa*.

pino, Hildebrand, Hermann Müller, and others abroad, and Dr. Gray and Prof. William Trelease in this country, have followed up this subject; and no one can familiarize himself with the results of their studies without a keen sense—if not a conviction—that in the vast number of cases Sprengel's early statement holds strictly true. By these deeper insights into the significances of the floral world, and their harmonies with the insect world, we learn to understand why night-blooming flowers are usually white, even where their day-blooming allies are brightly colored, as in the case of *Lychnis vespertina* and *L. diurna;* or why the calyx, which is usually hidden and green, becomes bright when exposed, as in the berberry and larkspur. Many flowers are known to close or "sleep," and while most of them follow the animal world in taking this rest at night, yet there are marked exceptions. The dandelion goes to rest at 5 P. M. and wakes at 7 A. M., while the popular names of "four o'clock" and "John-go-to-bed-at-noon" sufficiently indicate the sleeping hours of Mirabilis and Tragopogon. Sir John Lubbock tritely asks, "What is the meaning of sleep in flowers, if it is not in reference to insects?" The closing during those hours when the particular insects needed for pollination

are at rest, would protect the flower from spoliation by useless raiders. This belief is also strengthened by the fact that anemophilous flowers, or those fertilized by the wind, never sleep, and that flowers which attract insects by smell emit their odor at particular hours.

But the most interesting fact not commonly understood, that has now been very fully established by the most thorough researches, is, that a very large number of plants, even where the sexes are united in the same flower, absolutely depend on insect aid for pollination, and that the contrivances to induce cross-fertilization are infinite in diversity, while the modifications in structure which these insects have undergone the better to fit them to perform this service, are equally remarkable. Yet in most cases we have adaptation of the plant only, and except in a few instances, as, for instance, in that Madagascar orchid, *Angræcum sesquipedale*, where the nectary is so deep that its nectar can be reached only by a moth (like *Macrosila cluentius*) with a very long tongue, our orchids are not dependent for pollination on any one Lepidopterous species, but may be aided by many which have tongues of sufficient length.

There are, in fact, few plants which are dependent on a single species for pollination. So far as I know, the yuccas furnish the only instance of this kind, for they actually depend on some particular species of little white moths belonging to the Tineina and to the genus Pronuba. The yuccas are a very interesting genus of lily-like plants, so familiar to every one in our public and private gardens that I need not say very much about them (Fig. 1). There are numerous species and even sub-genera, but they are all characterized by anthers not reaching anywhere near the stigma, so that fertilization unaided can take place only by the merest accident. In other words, the stigmatic tube is nowhere within reach of the stamens, and the pollen either remains attached to the open and withered anthers or falls and remains in different-sized lumps on the inside of the perianth, and can not be introduced into the stigmatic tube without artificial aid.

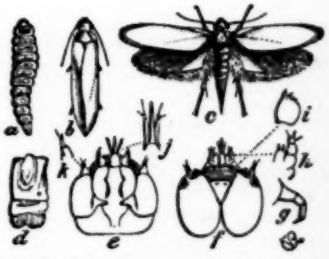


FIG. 2.—PRONUBA YUCCASELLA: *a*, larva; *b*, ♀ moth with closed wing; *c*, ♀ moth with wings expanded—natural size; *d*, side view of larval joint; *e*, head of larva, beneath; *f*, head of larva, above; *g*, thoracic leg of same; *h*, maxilla; *i*, mandible; *j*, spinneret and labial palpi; *k*, antenna—enlarged.

Our commoner garden yuccas, forms of *filamentosa*, depend on the commoner yucca moth, *Pronuba yuccasella* (Fig. 2, *b*, *c*), and so do all the different species found east of the Rocky Mountains, so far as we yet know. During the daytime we may, by knowing

what and where to seek, often find this moth, either singly or in pairs, resting with folded wings within the half-closed flowers. It is then not only hidden from ordinary view, but well protected by the imitative color of the front wings with that of the flower, so that close scrutiny is necessary for its detection. If we visit the plant after

"... the garish day
Has sped on his wheels of light away,"

and when, with full-blown perianth, the yucca stands in all her queenly beauty, and sends forth her perfume more strongly upon the night air, we shall, with a little patience, meet with this same moth, flitting swiftly from flower to flower and from plant to plant—the dusky nature of the hind wings and of the under surface of the front wings almost completely offsetting and neutralizing, when in motion, the upper silvery whiteness of the latter, and thus still rendering the insect a little difficult of detection. It is principally the male which we thus see flying and, by the aid of a "bull's-eye," we shall find the female for the most part busily at work in the flowers. He, with relatively stronger wing-power, can afford to spend in the most pleasurable way the few brief days allotted to him; but *she* is charged with a double duty, and loses little time in its performance. As a part of the maternal task of continuing her race, she must act as foster-mother to the plant in order to insure a proper supply of food to her larvæ, which, as we shall presently see, feed on its seeds.

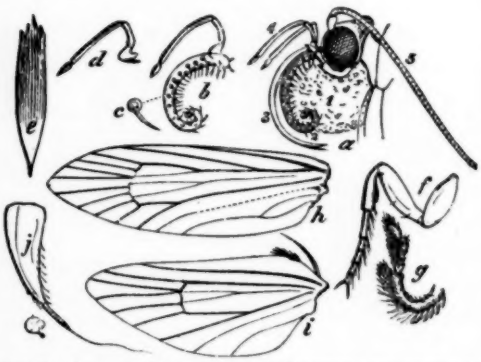


FIG. 3.—GENERIC CHARACTERS OF PRONUBA YUCCASELLA: *a*, side-view of head and neck of female denuded, showing how the collected load of pollen (1) is held by the tentacles (2); *b*, maxillary tentacle and palpus; *c*, an enlarged spine; *d*, palpus separated; *e*, scale from front wing; *f*, front leg; *g*, labial palpus; *h*, *i*, front and hind wings denuded; *j*, anal joint of female with ovipositor—all enlarged.

As preliminary to a better understanding of the habits of the female, it will be well to draw attention to those structural peculiarities which distinguish her from all other species of her order, and which so admirably fit her for the work she has to do. Fig. 3 gives some details of the head (*a*), and an important structure which more particularly characterizes her and interests us is the maxillary tentacle, shown with its palpus at *b*. She has a pair of these organs, which are prehensile and spinous, and it is chiefly by means of these that she is able to collect and hold a relatively

large load of pollen for the purpose of pollination. Another organ which is characteristic is the ovipositor (Fig. 4, *b*, *d*), which is delicate and extensile, being a combination of lance and saw, and admirably adapted for cleaving through the young fruit and then running the egg, which is long and filiform, into the ovarian cavity.

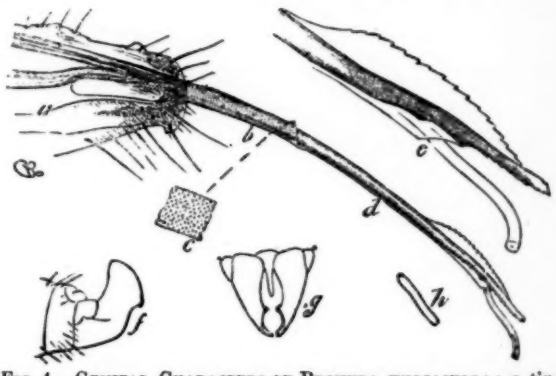


FIG. 4.—GENITAL CHARACTERS OF PRONUBA YUCCASELLA: *a*, tip of ♀ abdomen rendered somewhat transparent; *b*, basal joint of ovipositor; *c*, its sculpture; *d*, terminal joint of same; *e*, tip still more enlarged; *f*, genitalia ♂ from side; *g*, genitalia ♂ from above; *h*, undeveloped egg from ovary —enlarged.

Though all the acts of the female are nocturnal, it is not at all difficult to follow them with a lantern, for, albeit ordinarily shy, she may be closely approached when she is about to oviposit. Her activity begins soon after dark, but consists at first in assiduously collecting a load of pollen. She may be seen running up to the top of one of the stamens, and bending her head down over the anther, stretching the maxillary tentacles, so wonderfully modified for the purpose, to their fullest extent, the tongue uncoiled and reaching to the opposite side of the stamen (Fig. 6). In this manner she is able to obtain a firm hold of the same while the head is kept close to the anthers and moved peculiarly back and forth, something as in the motion of the head of a caterpillar when feeding. The maxillary palpi are used in this act very much as the ordinary mandibles are used in other insects, removing or scraping the pollen from the anthers toward the tentacles. After thus gathering the pollen, she raises her head and commences to shape it into a little mass or pellet by using her front legs very much as a cat does when cleansing her mouth, sometimes using only one leg, at another time both, smoothing and pressing the gathered pollen, the tentacles meanwhile stretching and curving. After collecting all the pollen from one anther, she proceeds to another and repeats the operation, then to a third and fourth, after which, with her relatively large load—often thrice as large as the head—held firmly against the neck and front trochanters, she usually runs about or flies to another plant: for I have often noticed that ovi-

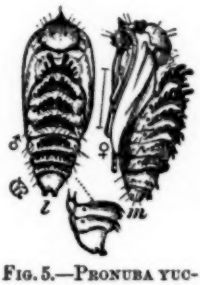


FIG. 5.—PRONUBA YUCCASELLA: *l*, male; *m*, female chrysalis —hair-line showing natural size.

position, as a rule, is accomplished in some other flower than that from which the pollen was gathered, and that cross-fertilization is thus secured.

Once fully equipped with this important commodity, she may be seen either crawling over or resting within the flower, generally with the head toward the base. From time to time she makes a sudden dart and deftly runs around the stamens, and anon takes a position with the body between and the legs straddling two of them, her head being usually turned toward the stigma. As the terminal halves of the stamens are always more or less recurved, she generally has to retreat between two of them until the tip of her abdomen can reach the pistil (Fig. 7). As soon as a favorable point is reached —generally just below the middle—she rests motionless for a short time, when the abdomen is slightly raised and the lance-like ovipositor is thrust into the soft tissue, held there the best part of a minute, while the egg is conducted to its destination, and then withdrawn by a series of up-and-down motions. Fig. 8 is a transverse section of the young fruit at this stage of the growth, indicating the manner in which it is punctured at *a*, *a*, and how the egg is conveyed into the ovarian cell at *b*, while Fig. 9 shows a longitudinal section of the pistil at *a*, the puncture of the ovipositor at *b*, and the egg within the ovarian cell at *c*.

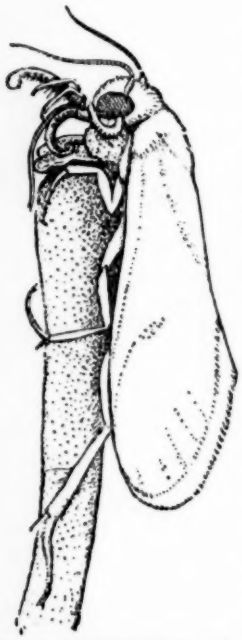


FIG. 6.—PRONUBA YUCCASELLA, female, in the act of gathering pollen from the anthers; five times enlarged.

The stigmatic liquor is not nectarian, and the flower secretes but a small amount of nectar at the base of the petals; and while these facts serve to disprove any positive value of their nectar in the pollination of the yucca flowers, they add to the importance of Pronuba by showing that the acts of collecting pollen and transferring it to the stigma do not result in any food compensation, as I was at first inclined to suppose. In other words, there is no nectar to allure other nectar-loving insects and cause them to go to the stigma; but, on the contrary, those which are drawn to the plant by the slight amount of nectar are led in the very opposite direction, viz., to the base of the style or of the flower. It is also an interesting fact that I have never noticed Pronuba feeding, as contradistinguished from pollinizing, for the motions of the tongue of Lepidoptera when feeding are quite characteristic and easily recognized. Indeed, the two pieces which form

the tongue are so often separated at tip, and so weakly joined throughout, as to raise the question, in connection with a somewhat imperfect alimentary canal, as to whether the moth feeds at all, and to suggest that the rather strong tongue, otherwise, assists pollination.

No sooner is the ovipositor withdrawn into the abdomen than the moth runs up to the top of the pistil, thrusts the pollen into the stigmatic opening, and works her head rapidly—the motion

FIG. 7.—FLOWER OF YUCCA, with near petals removed to show normal position of Pronuba in ovipositing.

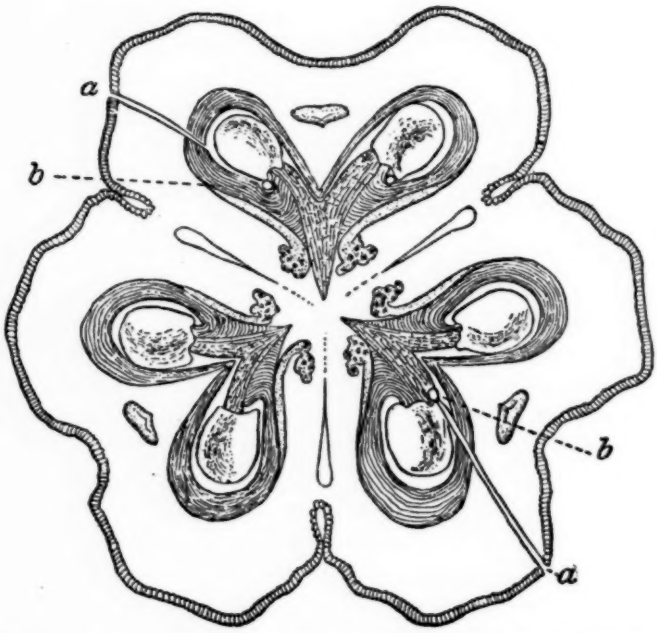
being mostly up and down and lasting several seconds. She works with a vigor that would indicate combined pleasure and purpose, and makes every effort to force the pollen into the tube, thrusting it ordinarily from the base of one of the three primary clefts of the style. After the more vigorous motions of thrusting the pollen into the tube, she frequently rests in comparative quiet, working her tongue in the tube sometimes for four or five minutes together, but ordinarily the act of pollination ceases with the few vigorous thrusts already described. The importance of this act will be better appreciated when I state that numerous experiments in artificial or brush pollination have shown that effective fertilization in *Yucca filamentosa* is by no means an easy matter, and that it rarely takes place as effectively as through the actions of Pronuba.

This carrying of the pollen to the stigma generally follows every act of oviposition, so that where ten or a dozen eggs are consigned to a single pistil, the stigma will be so many times bepollened.

The egg of Pronuba is an extremely delicate, thread-like structure, averaging 1·5 millimetre in length and less than 0·1 millimetre (Fig. 9, *c*) in diameter, tapering at the base and en-

larging slightly toward the capitate end, which has also a slightly indurated point. It is impossible to follow it with the unaided eye, or in fact with an ordinary lens, even if the pistil be at once plucked and dissected; but, by means of careful microscopical sections, we may trace its course, as shown in Figs. 8 and 9.

The larva hatches in about a week and will be found at a point from eight to ten ovules above or below the external puncture, according as the egg was thrust above or below it. It has no pro-legs, but has well-developed thoracic legs. It matures with the ripening of the seeds, which differs in time in the different species of yucca, and also in the same species, but occupies on an average about a month in the ordinary *Yucca filamentosa*. The number of seeds destroyed is rarely more than a dozen and more frequently less, and I have recorded the fact of having found as



8.—Transverse Section of Pistil, about middle, one day after oviposition, showing (*a*, *a*) puncture of ovipositor, and (*b*, *b*) position of egg.

many as twenty-one larvæ in a single pod. Just about the time the pods are hardening and ready to dehisce and the seeds have already colored, the full-grown larva bores its way out of the pod and makes its way to the ground. It remains as a larva within its cocoon during the fall, winter, and spring months, and only transforms to the chrysalis state a few days before the blooming of the yuccas. The chrysalis (Fig. 4), as shown in the figure, is armed with an acute spine on the head and with singular spatulate

spines on the back, which are well fitted to enable it to work its way to the surface from its underground retreat.

The effect of the puncture of the female moth in oviposition is at once noticeable on the young fruit by a darker green discoloration externally. In time this becomes a depression, and the irregularities of the pods (Fig. 9, *d, e;* Fig. 10, *b, c*) which have been considered characteristic of the fruit of the genus are chiefly due to these punctures, which, ordinarily occurring just below the middle of the pod, produce a more or less marked constriction there.

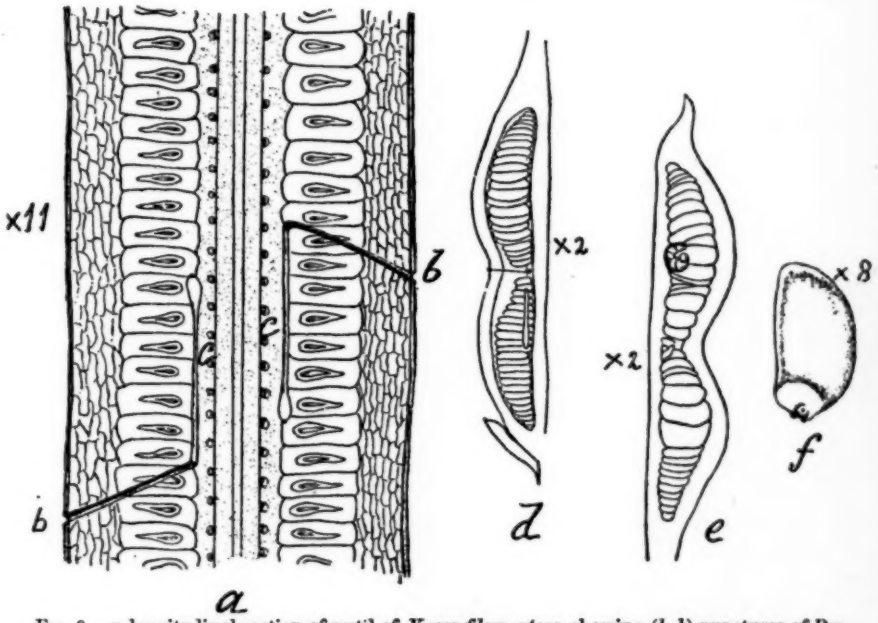


FIG. 9.—*a*, longitudinal section of pistil of *Yucca filamentosa*, showing (*b, b*) punctures of Pronuba, and (*c, c*) the normal position of her eggs in the ovarian cell; *d*, section of a punctured carpel seven days after oviposition, showing the egg yet unhatched and the manner in which the ovules in the neighborhood of puncture have been arrested in development so as to cause the constriction; *e*, section of an older carpel, showing the larva above the original puncture; *f*, a seed thirteen days from oviposition, showing young larva at funicular base.

This I have often proved by artificially pollinizing the flowers and protecting them from Pronuba, when the pods will develop in a regular, parallel-sided manner (Fig. 10, *a*).

It is noticeable that all the pods do not contain Pronuba larvæ, though we rarely find any on the filamentose species that do not show the marks of puncture, which indicates that a great many punctures are fruitless in result, owing either to the difficulty of the operation of oviposition, or to the fact that the eggs, having been once consigned to the pistil, have failed to hatch, for one reason or another; or again, that the larva has, for one reason or another, perished. A similar mortality is connected with the

similarly difficult and complicated oviposition of the *Cynipidæ*, as Adler has shown. In dissecting the young fruits of the filamentose yuccas, with a view to critical examination, I have found that about half of them, on the average, contain nothing; but the proportion varies greatly in different localities and according to circumstances, and I may say that, as a result of my numerous examinations, fully two thirds of the mature pods are found to contain the larvæ of Pronuba. All the experiments which I have so far made, or have known to be made, prove conclusively that the capsular species never set fruit without her aid.

Pronuba yuccasella is found in all parts of the country east of the Rocky Mountains where the filamentose yuccas normally range; but has not extended to all sections where they are cultivated. The time of its appearance is strikingly coetaneous, east

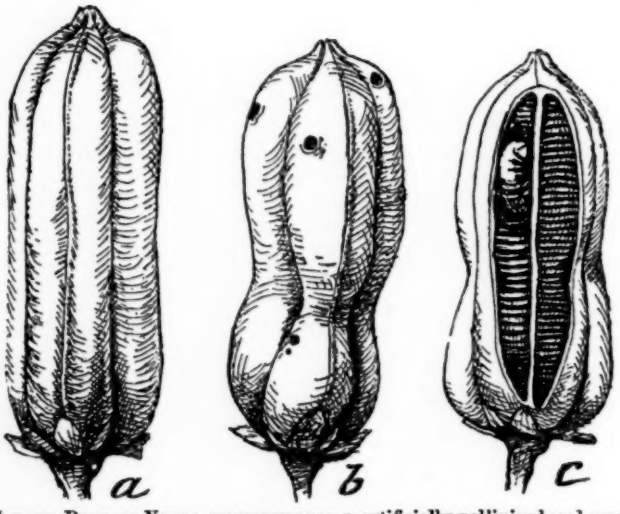


FIG. 10.—MATURE PODS OF YUCCA ANGUSTIFOLIA: *a*, artificially pollinized and protected from Pronuba; *b*, normal pod, showing constrictions resulting from Pronuba puncture and exit-holes of larva; *c*, one of the lobes cut open, showing larva within.

of the Mississippi, with the blooming of *filamentosa;* while other cultivated species which bloom either earlier or later, and which, therefore, do not receive the visits of the moth, I have, as already stated, never known to bear seed. On the Western plains, where *Y. angustifolia* is native, the moth's season of appearance is adapted to the flowering of this particular yucca. In California, *Yucca whipplei* is pollinized by *Pronuba maculata*, an invariably maculate species; while, on the Mojave Desert, *Yucca brevifolia* is pollinized by *Pronuba synthetica*, a species still more abnormal than *yuccasella* and modified to fit it to the peculiarities of that particular species of yucca. In the Gulf States the typical *yuccasella* occurs, and fertilizes not only the filamentose yuccas, but

those individuals of the larger, fleshy-fruited species like *aloifolia* which happen to bloom about the same time of the year.

Thus we find that some species of Pronuba is connected with all the yuccas so far studied in this connection, and I have no doubt that this will be found to be generally true, so far as the indigenous species are concerned, and that in the native home of any of the species we shall find that pollination depends upon some species of Pronuba. This is rendered certain by the fact that, wherever I have been able to examine the mature or partially mature fruit of other yuccas in herbaria, I have in almost every instance observed the constriction and in most instances seen traces of the puncture and the work of the larva.

We have, in the structures and functions which are so characteristic of this yucca moth, admirable adaptations of means to an end, whether for pollinizing the plant or providing for a future generation. The Pronuba larva rarely destroys more than a dozen of the seeds, so that several may develop within a single pod and yet leave many perfect seeds, while, for the reasons already stated, we occasionally have pods without a trace of the insect.

There is between Pronuba and its food-plant a mutual interdependence which excites our wonder, and is fraught with interesting suggestions to those who are in the habit of reasoning from effect to cause. Whether we believe, as I certainly do, that this perfect adaptation and adjustment have been brought about by slow degrees through the long course of ages, or whether we believe that they were always so from the beginning, they are equally suggestive. The peculiar structure of the flower which prevents self-fertilization, though on a superficial view it strike one as a disadvantage, is, in reality, of benefit, as the value of cross-fertilization has been fully established; while the maxillary tentacles of the female moth are very plainly an advantage to her species in the "struggle for life"; and it is quite easy to conceive, on Darwinian grounds, how both these characteristics have been produced in the course of time from archetypal forms which possessed neither, and in reality we get a good insight into the process in studying the characteristics of other species of the family *Prodoxidæ*. These peculiarities are, moreover, mutually and reciprocally beneficial, so that the plant and the animal are each influenced and modified by the other, and the same laws which produced the beneficial specialization of parts will maintain them by the elimination of all tendencies to depart from them.

The pollen grains would not adhere by chance to the rolled-up tentacles, and we have seen how full of apparent purpose and deliberation Pronuba's actions are. It may be that all her actions are the result merely of "blind instinct," by which term proud man has been wont to designate the doings of inferior animals;

but no one can watch her operations without feeling that there is in all of them as much of purpose as there is in those of the female Pelopæus who so assiduously collects, paralyzes, and stores away in her mud-dabs the spiders which are to nourish her young; or in the many other curious provisions which insects make for their progeny, which, in the majority of instances, they are destined never to behold. Nor can I see any good reason for denying these lowly creatures a degree of consciousness of what they are about, or even of what will result from their labors. They have an object in view, and whether we attribute their performances to instinct or to reason depends altogether on the meaning we give to those words. Define instinct as "congenital habit" or "inherited association" or, as I prefer to characterize it, as *the inevitable outcome of organization*, and most of the doings of the lower animals may justly be called instinctive; but instinct and intelligence are both present, in most animals, in varying proportion, the last being called into play more especially by unusual and exceptional circumstances, and the power which guides the female Pronuba in her actions differs only in degree from that which directs a bird in the building of its nest, or which governs many of the actions of rational men.

THE SURVIVAL OF THE UNFIT.

By HENRY DWIGHT CHAPIN, M. D.

IS modern civilization advancing along satisfactory lines toward a higher development? We hope and believe so, but there are not a few who consider such a question an open one. Both the pessimist and optimist can have much to say on either side of this problem. The forces at work in society are diverse and complex, acting like the ceaseless operation of a complicated engine that is constantly pushing on, throwing some up and some down, and leaving many a wreck behind. It is of pregnant interest to study the destructive factors at work in society that not only produce the unfit, but also tend to their survival. This question derives its principal significance from the apparently hopeless task of dealing with the unfit. Science and theology, from widely divergent poles, appear to reach much the same conclusion with regard to delinquents. Darwinism and Calvinism present about an equally hopeful consideration for the unfortunates of our race. One says heredity and environment; the other, predestination and foreordination. Both suggest the witty aphorism of Dr. Holmes, that the proper time to begin the treatment of some diseases is a hundred years before birth.

A glance at some statistics, published in the United States census reports will be interesting in this connection. The following figures are taken from a table showing the number of insane, idiotic, blind, and deaf-mutes in the United States, in the years named, respectively, according to the census:

	1880.	1870.	1860.	1850.
Defectives	251,698	98,484	68,451	50,994
Total population	50,155,783	38,558,371	31,443,321	23,191,876

According to these figures, the population a little more than doubled in thirty years, while the number of defective persons returned was nearly five times as great as it had been thirty years before. During the decade from 1870–'80 the increase in population was 30 per cent; during the same interval of time the apparent increase in the defective classes was a little more than 155 per cent. There is much talk about the increase of insanity in our day, and statistics appear to bear witness to the truth of such reports. The following shows the ratio of insane population to the entire population for the whole country in different years:*

1860..... 1 to 1,310.
1870..... 1 to 1,100.
1880..... 1 to 570.

The latest report of the Census Bureau states that the total number of insane persons treated in both public and private institutions during the year 1889 was 97,535, while during the year 1881 there were 56,205 treated; showing an increase in the nine years of 41,330, or 73·53 per cent. This percentage of increase, when compared with the percentage of increase of population in the last decade, namely, 24·86, does not necessarily indicate an increase in the proportion of insane persons to population, but rather a great increase in the amount of asylum accommodation provided, and a willingness on the part of the public to make full use of all the facilities thus offered. The bulletin states that the figures for the actual number of insane in the United States can not be determined until the work of eliminating all duplicate reports of cases has been completed.

The ratio of insane in public and private institutions of the United States is to the entire population as 1·56 to 1,000.† As these figures represent only institutions to which large numbers of the mildly insane are never sent, they point to an increase in insanity. Objections may be made to figures tending to show a

* Dr. C. L. Dana, in Journal of Nervous and Mental Disease, April, 1882.
† Census Bulletin, No. 62, May 9, 1891.

relative increase of the defective classes, on the ground that statistics are now much more carefully collected than formerly, which is certainly true. It may be said, however, that errors in the returns of the defectives were not confined to this class, but were more or less distributed among the different elements of population. The accurate collation of defectives is a task of great difficulty. While their number is now relatively better known than formerly, their absolute number will never be as accurately tabulated as other parts of the community, but a study of statistics shows that they tend to increase.

With regard to paupers, the recent census shows the total number in almshouses to be 73,045.* The number reported in 1880 was 66,203. The ratio of almshouse paupers to the total population at that time was 1 to 758; the ratio in 1890 was 1 to 857, showing a decrease. This decline in the ratio is attributed to the very much smaller number of paupers cared for in the almshouses in the North Atlantic division. It is interesting to note that the foreign population of this country contributes, directly or indirectly, very nearly three fifths of all the paupers supported in almshouses. There is no way of learning the number of outdoor poor—which is large—as they are supported, partly or in whole, by private charity. Mrs. Lowell estimates that the number of paupers in the public and private institutions of New York city, totally supported at any one time, is about 28,000. The cost of maintaining them during 1890 was $3,794,972. She further states that, if we go back forty years, we find that the increase of contributions of public funds to private persons for the support of private paupers has been from $9,863 in 1850 to $1,845,872 in 1890, and that the amount is nearly two hundred times what it was forty years ago. The increase of expenditure for public paupers, through the hands of public officials, has been at a much less ratio, increasing from $421,882 to $1,949,100 during the same interval of time.†

What is society to do with its horde of defectives? Unfortunately, it does practically nothing to check their production. The sources of the muddy stream are left untouched, while larger and larger reservoirs are being constantly built to collect and conserve the contaminated flow. One can not help noticing how this humanitarian age is abundantly equipped with asylums, almshouses, reformatories, and hospitals of all kinds. If the good accomplished by such agencies could be measured solely by relief of suffering and cure of disease, the results would be nothing but gratifying. A collateral danger is in keeping alive

* Census Bulletin, No. 90, July 8, 1891.

† Christian Union, August 25, 1891.

sickly and defective classes, who are often as prolific as they are inefficient. In our civilization these institutions have become a necessity, but their abuse should be carefully guarded against. What is urgently needed are homes or retreats where poor convalescent patients can recuperate after their discharge from the hospital. As it is, such people, in a weakened condition, have no place to seek the needed rest, and either fall victims again to a former disease, or become chronic invalids. Here would seem to be a more fruitful field for philanthropy than the building of additional hospitals. Above all, more of an effort should be made to get at the roots of the cause than to temporize so with the effect. Municipal governments annually devote large sums of money for the care of the sick, the criminal, and the insane, but devote no energy to investigating and striving to prevent the factors that are constantly at work in producing these classes. Here, if ever, an ounce of prevention is equal to many pounds of cure. The Department of Public Charities and Correction of New York city, with its 15,000 wards, received $2,166,237 in 1891, and requests an appropriation of $2,877,245 for 1892. If a part of the money that is annually devoted to keeping alive the helpless and suffering could in some way be diverted toward remedying unhealthy domiciles, relieving overcrowded tenements, dissipating polluted air and foul gases, supplying the best food at cheap rates, educating the masses in the simple principles of hygienic living, closing the saloons, and in many like ways checking the sources of disease and degeneration, this knotty problem would find its best solution. The way we can cure is by preventing. We permit factors to exist that degenerate men physically, mentally, and morally, and then bring up a clumsy, mechanical, outside philanthropy to try and reform by patchwork.

Probably one of the greatest dangers to organized society is found in the criminal classes. The laws of the production and confirmation of criminals, with their treatment, should be among the most thoughtfully studied branches of political science. The number of convicts in penitentiaries in 1880 was 35,538, while in 1890 it was 45,233, an increase in ten years of 9,695, or 27·28 per cent, and during this interval the total population increased only at the rate of 24·86 per cent.* Again, the total number of prisoners in county jails in 1880 was 12,691; in 1890, 19,538, an increase in ten years of 6,847, or at the rate of 53·95 per cent.† Coming to the inmates of juvenile reformatories, we find the number reported in 1880 was 11,468; in 1890, 14,846, an increase of 3,378, or

* Census Bulletin, No. 31, February 14, 1891.

† Census Bulletin, No. 95, July 14, 1891.

29·46 per cent.* It is thus shown by recent statistics that the various grades of criminal population are increasing more rapidly than the population at large. The same results have been shown by previous census reports. It must also be remembered that a large number of actual criminals are not under confinement, and are hence not included in the figures showing their increase. It has evidently become a vitally important question for decision by society as to the best plan to pursue toward the criminal. In dealing with this problem too much stress is popularly laid upon merely punishing the malefactor. Popular conceptions of the nature of punishment have varied widely with the age. The earliest enactments of penalty were, in form, vindictive; next retributive; and, finally, as the highest conception, reformatory. While the State, uninfluenced either by vindictive feeling or pity, deprives criminals of liberty for a time as a measure of self-protection, it must adopt some mode of treatment during incarceration. The old plan consists in getting a certain amount of work out of them to aid in their support, but without making any effort at reform. The unexpressed idea appears first to get even with them, and then kick them out upon society, usually to begin depredations again. An abnormal mental and moral atmosphere is diffused in such a prison, and the large congregation of criminals is a school for confirming the vicious. The reformatory plan aims at the prisoner's rehabilitation, so that there may be some hope of right behavior after release. This result is sought by means of physical renovation, industrial and intellectual education, and general moral impression. In order to satisfactorily apply these agencies the science of penology has shown an indefinite sentence with a conditional discharge, including partial oversight after discharge, to be necessary. It is a fact proved by statistics that a large percentage of criminals are defective either physically or mentally, and have had an unfavorable heredity and environment.† Under the general system in this country no attempt is made to rehabilitate them during confinement. Criminals are first made to a certain extent by unfortunate heredity and unfavorable social conditions, and then confirmed by imprisonment. Weak character and environment bring out the unfittest elements, and society by its treatment hastens to provide for their survival. When we see that, accord-

* Census Bulletin, No. 72, May 27, 1891.

† Of 552 convicts received at the State Penitentiary for the Eastern District of Pennsylvania in 1886, 263 were found in a condition of impaired health, and 174 were in an unsound mental condition, as follows: Insane, 12; epileptics, 7; mentally undeveloped, 61; weak intellect, 77; idiotic, 17: 159 were inclined to grave diseases of the neurotic type, which tend to modify the moral, mental, and physical condition from inheritance of bad formation.

ing to past census reports, crime has more than doubled every ten years for the past half-century, the importance of this subject becomes manifest. The most practical and successful trial of the advanced method in this country is seen at the Elmira Reformatory. Here the prisoner goes to school and receives the needed bodily and mental training, by which it is endeavored to form a stable base for moral improvement.

In conclusion, we must repeat that, in our consideration of the defective and delinquent classes, more attention should be given to *prevention*. Let our greatest energies be devoted to combating the conditions that are at work in society producing the unfit, rather than so industriously providing for their survival. When such a class is formed, it should be permanently isolated from the rest of society. Recent legislation in Ohio adjudges a person an habitual criminal when convicted of a third offense, under which he may be held for life. This law is based upon sound physiology and psychology. Such a permanent quarantine should be applied to all tramps, cranks, and generally worthless beings. Society must do this for protection, not punishment; to avoid their contamination; and, above all, to prevent the propagation of their kind. Advanced sociology will devote its principal energies to avoiding the production of the unfit, and then see to it that they do not survive beyond one generation. Here lies the only solution of this difficult problem—first prevention, next permanent isolation.

THE ANCIENT CIVILIZATIONS OF AMERICA.

By Prof. JOHN S. NEWBERRY.

WHEN the white man landed on these shores he found them covered with a dense forest, the home of the bear, the elk, the lynx, and the other wild animals indigenous to this country. The only human inhabitants were the red Indians, who roved the forest, "the children of the shade"—the chase their occupation, and their amusement war. From Maine to Florida the country was overrun by various tribes of these untutored savages, and for many years it was believed that the whole of North America was what it was called—*the New World*—and that its animals and savage men were part of the first wild stock with which it was peopled.

As the wave of civilization moved westward the forest was mowed down before it, and step by step the native tribes—with many a hard-fought battle and bloody tragedy—were driven deeper into their forest recesses.

Behind the advance guard of the whites the country was soon

dotted with hamlets, which grew to towns, and these in time to cities. The intervals between them were covered with grain-fields and orchards, of which the growth was so luxuriant that it seemed to prove the soil to be now for the first time opened to the sunlight. Thus several generations passed; but in time the invading hosts pressed through the great natural water-gap, which once connected the Hudson with the lakes, or crossed the Alleghanies from Pennsylvania and Virginia, and took possession of the basin of the Ohio. Here they entered their promised land—the valley of the Mississippi—a region which by its broad topographical unity, its universal fertility, its network of navigable waters, and its unequaled mineral resources, is without a rival on the earth's surface in its fitness to become the home of a great nation. Here, too, the wandering and stealthy savage was in full possession, and resisted the invasion of his hunting-grounds with his characteristic ferocity.

Ultimately, however, he was compelled to yield to the superior numbers and intelligence of the whites, and, within fifty years from the first struggle on the "dark and bloody ground" of Kentucky, he had practically abandoned all the territory east of the Mississippi.

When the forests were opened in this region, it was for the first time discovered that the nomadic Indian was not autochthonous, and that he had been preceded by a sedentary and partially civilized people, who had cultivated the soil, worked the mines, and left behind them a vast series of monuments which extended from the Alleghanies to the prairies, from the Lakes to the Gulf. These monuments consisted of *mounds, walls, fortifications,* and other structures composed of earth or rough stone, and among them the mounds (chiefly sepulchral) were so conspicuous from their numbers and size that the people by whom they were constructed—and whose name and history had been utterly lost—for want of other designation were called *the Mound-builders.*

The records of this ancient people, with the lessons they teach in regard to their degree and kind of culture and their ethnical relations, will be referred to again. Meantime we will pass to notice a still more extensive and interesting series of monuments which attest the ancient occupation of America by *civilized* man.

Long before the Northern whites had entered the valley of the Mississippi, and had discovered the first traces of the mound-builders, the Spaniards who invaded Mexico and Peru found there a civilization in many respects superior to their own—a civilization which extended throughout Mexico, the Isthmus, and the west coast of South America to the frontiers of Chili; that had produced cities that rivaled in extent and in the magnificence of their buildings those of the Old World—cities that were lighted

at night, guarded by police, that contained palaces, temples, courts of justice, schools of law, medicine, music, and literature, with parks, aqueducts, fountains, and artificial lakes.

The cities were connected by graded roads, on which were stations and relays of messengers for the rapid transmission of intelligence. The population was divided into various castes, including royalty, nobility, different grades of traders and artisans, and finally slaves. The country was cultivated with much agricultural skill, and in the towns were workers in *gold, silver, copper,* and *bronze.* Their military organization was thorough and effective, and strategic points were guarded by fortifications, some of which have had no rivals in magnitude in the history of the world.

This civilization, imposing as it was, at the advent of the Spaniards had passed its golden age, was then in its decadence, and has since, chiefly by the brute force, cruelty, and rapacity of the European invaders, been nearly driven from the earth.

So much has been written of these two American civilizations —that of the mound-builders of the Mississippi Valley, and that of the palace-builders of Central America—and their study has been pursued with so much interest and success, that it may seem presumptuous that I should venture to occupy the hour kindly granted me with a theme so broad and already so familiar. But it has happened to me to traverse much of the territory in Central America, Mexico, and the United States where the relics of these bygone races are most abundant, and as the subject has always been one of intense interest to me I have lost no opportunity of gathering by my own observation such information as came within my reach; hence, it is possible that I may be able to contribute something to what you may have learned of our predecessors in the occupation of this continent, and of the real and original American citizen.

THE MOUND-BUILDERS.—As has already been mentioned, traces of a people more advanced in the arts than the nomadic Indian are spread over the entire valley of the Mississippi and the Lake basin. These have been so fully described that you are familiar with their general character, but few of us have a just idea of their number and magnitude.

It is estimated (but I fear with little accuracy) that not less than ten thousand monuments of the mound-builders are contained within the limits of Ohio, and they are scarcely less numerous in the adjacent States of Indiana and Kentucky. In some places, as at Newark and Circleville, they cover square miles of surface, and it is hardly to be doubted that they are the work of a people or peoples not less numerous than the present population.

They are most abundant where the agricultural capabilities of the country are greatest, and we find them associated with areas of special fertility in such a way as to prove that they had stripped the forest from these areas, and chiefly derived their subsistence from their cultivation. Hence we learn that they were a sedentary and agricultural people. Yet their structures are for the most part earthworks—walls for defense, or to form inclosures, sepulchral mounds, etc.; and while we find what seem to be raised foundations of extensive buildings, those buildings have disappeared, and we must hence conclude that they were for the most part structures of wood.

The mound-builders were ignorant of the use of iron, and probably possessed no other metals than copper, which they mined extensively, but never smelted; for we find their implements composed of the native metal, often with specks of silver, thus betraying its source on Lake Superior, and only hammered into shape. From this copper they made battle-axes, daggers, knives, awls, and ornaments; but most of their tools and weapons were of stone, and many of them were laboriously and tastefully wrought.

They have left no evidence that they had a knowledge of masonry—an art in which the inhabitants of the table-lands so much excelled.

This is the more remarkable, as stone easily quarried abounds in the vicinity of their works, and some of the great structures of our Western table-lands, whose builders apparently had not the use of metals, show what good work could be done without metallic tools.

I have said that the mound-builders made use of but a single metal—copper—and yet they were industrious and enterprising *miners*. Their copper mines on Lake Superior have been often and fully described. They must have been worked for generations, since the ancient excavations exceed in magnitude all the work of the white man in that region; but the methods which they used were exceedingly rude and simple.

They had no knowledge of metallurgy, and the Lake Superior copper was only available for their purpose *because* it occurs in the metallic state. They excavated the rock by the use of fire, stone hammers, and wooden shovels.

They never penetrated the earth to a greater depth than sixty to eighty feet, and for ladders they used the trunks of trees from which the branches projected at frequent intervals, and these were cut off to form steps. Since no considerable structures belonging to this people have been found near the Lake Superior mines, it seems probable that their mining operations were carried on only in summer, and by parties who, migrating from the lower country in the spring, returned in autumn.

Although the copper mines of the mound-builders were their most important ones, they had others by which they procured things that were of no less value to them. Of the coal, which constitutes the mainspring of modern civilization, and of iron, its most important adjunct, though existing in unequaled abundance in the country they inhabited, and trodden under foot in their daily vocations, they seem to have been utterly and strangely ignorant. Yet they worked with much labor the *mines* of *mica* in North Carolina, from which they procured what was by them highly prized as an ornament; *the soap-stone quarries* of the Alleghany range, where they obtained material for their domestic utensils and the all-important ceremonial pipe; and those of flint in Ohio and elsewhere, from which came the material out of which the greater number of their tools and weapons were fashioned.

In addition to these, I can assert from my own observation that they worked at least *one lead mine* in Kentucky, and sank wells from which they obtained petroleum in all our principal oil regions.

As these facts have not been reported by others, and yet are unquestionable, I venture to emphasize them with a few words of description.

Near Lexington, Ky., is a vein of lead ore which is traceable for half a mile or more through cultivated and forest land. The ore is galena in heavy spar, which has resisted the solvent carbonic-acid water that has removed the limestone wall rocks and shows conspicuously at the surface. Thus it attracted the attention of the mound-builders, who seem to have prized the galena only for its brilliancy, as we find it in many of the mounds, but so far we lack evidence that it was smelted. To obtain it in the mine to which I have referred, they made a deep trench along the course of the vein, taking out the ore to the depth of perhaps ten or twenty feet. One hundred yards or more of this trench is now visible, running through forest which has never been disturbed by the whites. Here it is five or six feet deep, and is bordered on either side by ridges of the material thrown out. On these, trees are growing which have reached their maximum dimensions, showing that at least five hundred years have elapsed since the mine was abandoned.

The working of the oil wells by the mound-builders is as plainly proved. When drawn to Titusville by the first successful oil wells, I was struck by the peculiar pitted surface of the soil of the forest which covered the bottom lands of Oil Creek. The pits were ten feet or more in diameter, and two to three feet deep, contiguous, and innumerable. Subsequently I discovered that each of these funnel-shaped depressions marked the site of an ancient well, sunk through the alluvial deposits, but not into the rock.

One of these, just opened in an excavation for a new oil well, showed a pit twenty-seven feet deep, cribbed up with timber, and containing a rude ladder like those found in the Lake Superior copper mines. The timber used for the inclosure of the ancient pit had been cut with a blunt-edged instrument, doubtless of stone.

I afterward found similar pits in the oil regions of Kentucky and Tennessee, at Mecca and Grafton, Ohio, and at Enniskillen, in Canada. In the latter locality the oil was obtained by sinking pits to the depth of forty or fifty feet in the Drift clay, the oil issuing from crevices in the underlying rock and accumulating beneath the clay. In the excavation of one of these pits an ancient one of similar character was brought to light. This was filled with rubbish, twigs, leaves, etc., and a pair of antlers was taken from it at a depth of thirty-seven feet. The antiquity of this pit, like those of Oil Creek, was proved by the large trees growing over it.

The contents of their sepulchral mounds have supplied some information—though less than we desire—of the domestic habits of the mound-builders. Usually the bones they contain are so much decomposed in the lapse of time that they have given us but an imperfect knowledge of their osteology. From the few remains found well preserved we may, however, infer that as a people they were of average size, of fair proportions, and with a cranial development not unlike that of our modern Indians. The jaws were somewhat prognathous; their teeth—as is usual with all peoples who make much use of their jaws *for mastication*—are strong and regular; and the wisdom-tooth, which in our jaws, shortened by disuse, has inadequate room and is of little value, was with them one of the largest and most useful of the set. On account of the lengthened under jaw, the incisors met in direct opposition, and apparently because they used their teeth for grinding seeds of which the envelopes contained much silica, they are often found uniformily worn down nearly to the jaw. We know little of the crops the mound-builders cultivated except that their great staple was corn, and that they raised and used tobacco.

They buried their dead with imposing ceremonies, and not unfrequently cremated their remains on a kind of altar which occupies the center of the sepulchral mound, and, as is the habit with perhaps all primitive people, vases, weapons, tools, and ornaments were buried with the body. Of these the pottery sometimes shows considerable taste and skill—the vessels having graceful forms and being often ornamented with colors or with incised designs. The weapons and implements that are found so abundantly in the mounds and scattered over the surface are rarely of copper, generally of stone. Of these the arrow-heads, spear-heads, daggers,

augers, and hoes are usually of flint; their axes and celts are generally made of green-stone, a tough and heavy rock specially adapted to such use; the celts were inserted in handles and closely resemble those of the polished-stone period in the Old World. Their axes, all grooved for a withe, were frequently wrought with great skill and patience. The most common ornaments found with the remains of the mound-builders are anklets or armlets of copper, and strings of beads of shells or bone, of copper or baked clay. In addition to these are many large ornaments of shell or stone perforated for suspension from the neck or for attachment to the head.

Of the clothing of the mound-builders we have as yet little information, since the lapse of time has caused fabrics of vegetable or animal fiber to perish. In a few instances, however, the antiseptic properties of copper salts or special conditions have been the means of preserving some fragments of cloth made from the fibers of a plant. Of these the workmanship is so good that we may believe that woven fabrics were largely used for clothing.

In regard to the ethnic relations of the mound-builders, the age in which they lived, and the causes of their disappearance, much has been conjectured, but little can be asserted. As to the time in which they lived in the country they inhabited—when and how long—this at least may be said, viz., that they occupied all the forest-covered region of the Mississippi Valley—to which they seem to have given a decided preference—for many hundreds and perhaps thousands of years. This is indicated by the general occupation of this wide-spread area, the magnitude and number of such of their works as have resisted the ravages of time, and the great abundance of the stone implements of their manufacture found scattered over the surface; also by the extent of their mining operations on Lake Superior and elsewhere. All this can mean nothing less than the long-continued possession of the country.

The general distribution throughout the valley of the Mississippi of shells obtained on the Gulf or Atlantic coast; the copper, mica, galena, flint implements, etc., all of known origin, indicate considerable internal interchange of commodities, but furnish no proof of a foreign commerce.

In regard to the origin of these peoples little is known. We may infer from their bony structure that they belonged to the American family of men, and were not unlike, in structure, physical aspect, and color, the red Indian of to-day.

A few stone tablets have been found in the mounds, which are decidedly Mexican in character; and if, as seems probable, the authenticity of these relics should be established, they would go far to prove synchronism and intercourse between the mound-

builders and civilized races of the South; but this does little or nothing toward establishing a relationship between them.

As to *when* and *why* and *how* the mound-builders disappeared we can form a more accurate and reliable conception. A large number of the monuments left behind by them are of a defensive nature; in some localities, as in the valley of the Cuyahoga, near Cleveland, every headland which overlooks the river is crowned with a fort or citadel; and it is evident that those who occupied this and many other areas of the Mississippi Valley were engaged in a constant struggle with persistent, harassing enemies.

Following the migrations of the various tribes of the modern Indians (as we are able to do chiefly by the clew of language) we learn that they have come from the North, and have for hundreds of years been pushing by devious and interlacing routes southward to occupy the territory once possessed by sedentary, peaceful, and agricultural peoples—the mound-builders in the East and the stone-house builders in the West.

Limitation of time forbids the citation of the proof of this northern invasion, but it is sufficient to convince those who have most carefully studied the subject. We may therefore accept the conclusion that in America, as in Europe, hordes of northern barbarians (multiplied by the fecundity of a cool and healthful climate, and inspired by the force and restlessness acquired in their strife with Nature's obstacles) invaded southern lands whose more fertile soil and genial but enervating climate developed the arts of peace at the expense of those of war.

The commoner belief has been that the ultimate fate of the mound-builders was entire extinction; but there is good reason to believe that in the Natchez and Mandans, and perhaps some other tribes still existing, but in small numbers, at the advent of the whites, we have their lineal descendants. The grounds of this conclusion can not be fully set forth here, but it may be said that the tribes referred to in many respects contrast strongly with the more numerous and characteristic inhabitants of the country; and also that their customs and arts, their implements and structures, bear a close resemblance to those of the former occupants of the Mississippi Valley.

As to the time which has elapsed since the mines and structures of the mound-builders were abandoned we have only negative evidence. The heaps of *débris* about the Lake Superior copper mines, the filled-up oil wells, and the earthworks of Ohio, Kentucky, and Tennessee, were found by the incoming whites covered with dense forests in which the trees had attained their maximum size. Beneath this present generation of trees, and overgrown by their roots, were lying the prostrate and decaying trunks of a preceding generation. We thus have evidence that

at least a thousand years had elapsed since the country was *abandoned* by its former inhabitants, and their fields and villages were overgrown by the forest. Beyond this point all dates are left to conjecture.

One interesting feature in the Western mounds is that many of them, especially in the prairie regions of the Northwest, are made to imitate, on a gigantic scale, the forms of men, quadrupeds, and birds, and among the animals thus represented is what seems to be the elephant or mastodon. Small figures of an elephantine animal also appear in the archæological collections of the Northwest, and are claimed to be authentic. These relics go far to prove the acquaintance of the mound-builders with either the mastodon or mammoth, and may be accepted as presumptive evidence of the synchronism of man here, as in Europe, with one or both of these great pachyderms—and hence of his great antiquity.

THE PALACE-BUILDERS.—The remains of an ancient civilization, scattered over the west coast of South America, the Isthmus, and Mexico, are so varied and interesting that they form a theme to which nothing like justice can be done in the few minutes at my disposal. Detailed descriptions of these great monuments are, however, the less necessary, since many volumes have been devoted to their exposition. Those who have access to Squier's Peru, Stephens's and Catherwood's, Norman's and Waldeck's books on Central America, or Lord Kingsborough's great work on Mexican Antiquities, will find there, and in the documents cited by their authors, a literature scarcely less rich and interesting than that formed by the records of the Egyptians or Assyrians.

Of this vast field I can give you but the merest sketch, but, as part of it lies within our own territory, and as in its exploration I have taken part, I can perhaps add some facts additional to those you have learned, and such as will compensate for the time they may occupy. To summarize, as briefly as possible, the knowledge we have of this subject, I may say that from the frontier of Chili to Salt Lake, there exists an almost uninterrupted series of monuments of a civilization which, though locally peculiar, was generically the same, and unquestionably the product of divergent streams flowing from a single source. The typical and characteristic remains of this civilization consist of great works of masonry and engineering (fortifications, temples, palaces, communal houses), which in their magnitude and perfection of workmanship rival the masterpieces of ancient architecture. Bridges, aqueducts, and thousands of miles of paved and graded roads attest the engineering skill of the people by whom they were constructed.

Honduras, Yucatan, and Colombia would seem to have been the

center of this civilization. It is true that the monuments of Peru are equally extensive and imposing as those already discovered in Central America, but they are far better known; and we have reason to believe that, buried in the almost impenetrable forests of Honduras and the Isthmus, there still remain more extensive and interesting ruins than any yet brought to light. There is little doubt that here we have the richest field for future explorations, and a source from which we may hope for more light upon the history of the peoples whose works we are considering.

In regard to these peoples, however, there is no such mystery as clings about the mound-builders. Though stripped of much of its former power and glory, the civilization of the Incas and the Aztecs was still in active life at the time of the invasions of Cortes and Pizarro; though, under the hand of the oppressor, the native population, with all its complicated systems of laws, religion, customs, and literature, was rapidly destroyed or degraded beyond recognition. As we know, the chronicles of the old Spanish historians are somewhat highly colored, and the wealth, magnitude, and splendor of the cities they conquered were magnified by the Spaniards to enhance the glory of their exploits. There can be no doubt, however, that in both North and South America there were found civilized and wealthy nations, far advanced in all the arts then known in Europe, except the working of iron, and with a perfection of political, social, and religious organization that can not fail to excite our wonder and admiration.

As proof of the reality of the advancement in the arts and the solid achievements of the Peruvians, Mr. Squier tells me that the great Incarial road, which reaches from Quito to Chili, is a work of far greater magnitude than our Union Pacific Railroad; that some of the public buildings of the Peruvians were constructed of masonry that in its perfection is not surpassed by the finest monuments of ancient or modern architecture; also, that a single fortress guarding one of the passes through which the wild hordes of the upper Amazon sometimes entered Peru, was a mightier mass of masonry than would be formed by heaping together all the forts upon our coasts from Maine to Mexico.

As an evidence of the wealth of the country, it is reported that the gold and silver vessels brought for the ransom of Atahualpa, and which, as we read, filled his prison as high as he could reach, had a value of something like twenty-five hundred thousand dollars; and it is said further that the gold plates and ornaments stripped from the Temple of the Sun at Cuzco were worth not less than one million dollars.

The essential unity of the civilization which covered all the country containing the monuments referred to is attested by the resemblances in religion—for all was sun-worship—in language,

in customs, in style of building, and especially by a peculiar skill in the construction of works of masonry, in the manufacture of pottery, and in ornamental decoration. That there were marked local differences, and that this civilization was shared by independent nationalities, is certain; but it is no less true that it sprang from a common source, and was harmonized by constant intercourse through hundreds and it may be thousands of years.

Since a large population was found inhabiting the cities and embodying this civilization at the time of the conquest, it would seem that everything important could be easily learned about this peculiar phase of human development. But it should be remembered that the propagation of the Christian faith was a motive only less strong than the thirst for gold in the Spanish invaders, and a bigotry ferociously intolerant of all heresy made it a cardinal virtue to destroy every representative of pagan creeds and rites.

Hence from religious as well as political causes the conquest was followed by a destruction which soon swept away nearly all traces of the literature, customs, and government of the conquered people, and did all that was possible to bury their history in oblivion. Fortunately, among the numerous monks who attended the invading armies were a few possessed of scholarly tastes, who described what they saw, and, perhaps surreptitiously, translated some of the ancient hieroglyphic records, and preserved vocabularies of some of the dialects then in use. These have furnished a clew to the interpretation of some at least of the abundant inscriptions in Central America, and we can not doubt that by the earnest following of this clew, and the patient application of the methods which have revealed the secrets of the Egyptian hieroglyphics and the Assyrian cuneiform characters, we shall obtain from the Central American records much light upon the history of the civilization we are considering.

In Mexico and Peru few inscriptions are preserved, and yet we know that the art of writing on paper, or its equivalent, was practiced in both countries.

Unfortunately, it was not the habit of these peoples, any more than it is with us, to make enduring records on stone, and the loss of the ephemeral manuscripts which existed at the time of the conquest is an irreparable one. There is little doubt, however, that when the inscriptions of Palenque, Uxmal, Copan, Chichenitza, etc., shall be translated, the mystery which has so long hung over the origin and progress of all this phase of intellectual culture will be dissipated.

Those who believe—as some do—that the Peruvian civilization is distinct from and totally independent of that of Central America and Mexico, will not share the hopes I entertain from the

translation of the abundant records of Yucatan. But no one can compare the pyramidal structures of central Mexico, Tehuantepec, and Huanaco, or the style of architectural ornamentation of Mitla, Uxmal, and Granchimu, without feeling that they are the work of a people who were generically the same. The striking and peculiar images in gold, silver, and alloy, as well as the pottery of Peru, of Bogotá, and Chiriqui, afford confirmatory evidence of this unity.

The intercourse between these neighboring and cognate nations was undoubtedly for the most part by sea. Columbus met traders from cities of Central America at Ruatan, where they came in a vessel of considerable size, carrying sail and manned by twenty sailors; and Pizarro, on his way to Peru, when near the equator, encountered a vessel of the Peruvians, which he says "was like a European caravel," and was loaded with merchandise, vases, mirrors of burnished silver, and curious fabrics of cotton and wool, the latter undoubtedly made from the wool of the llama. With such vessels it would be easy to pass from the Mexican to the Central American and thence to the South American ports; and we have incidental evidence that this was done. Louis Hoffman, a German mining engineer, who was one of the scientific corps attached to the staff of Maximilian, and who on professional duty visited all the mining districts of Mexico, tells me that on the Pacific coast, directly south from the city of Mexico, in a region abounding in ruins yet unstudied, at the mouth of a river, is what was once a large seaport town. From this point the passage would be direct and easy to Tehuantepec, Panama, and thence southward.

The question of the origin of the Mexican and Peruvian civilization has been much discussed, and various views have been advanced in regard to it: by some, that it was the fruit of seed borne across the Atlantic by the Phœnician traders, and was therefore of European origin; by others, that it was a remnant of the civilization that pervaded the fabulous country of Atlantis, which once stretched from Central America far over toward the Old World, from which it was separated by a strait that was easily passed in the original dissemination of the human race.

It must be said, however, that with the exception of some features which are common to all phases of human culture, and are the spontaneous outgrowth of qualities which are inherent in all peoples—or are the records of creeds or customs which prevailed in the cradle of the human race, wherever that be—there is nothing whatever to indicate a borrowing from Egypt or Tyre or any European nation. On the contrary, there are an originality and independence in all the forms in which this civilization was embodied that prove that it was either indigenous and grew from

small beginnings in the country where it subsequently attained its full development, or was imported in its embryonic state from the Oriental Archipelago. There are some things which indicate that its germs were derived from the latter source. On Ascension and Easter Islands there are large structures of stone with huge columnar engraved monuments. Remains of similar character are reported from the Sandwich, Kingsmill, the Ladrones, Navigator's, and other islands of the Pacific; and it is evident that, in times so ancient that all memory of them is lost, a people inhabited these islands who had many of the arts of civilization, and who were essentially and characteristically workers in stone. The similarity of the works on these different islands indicates their progressive occupation by a people who were compelled, in passing from one to another of their stopping-places, to traverse as great a breadth of ocean as separates some of these from the American continent; and it is not improbable that the final resting-place of this people was upon the western coast of the great double continent, of which the continuous Cordilleras, like a great wall, arrested their eastward migration. Here they spread from their center of radiation to Chili on the south and to Utah on the north, elaborating in the course of time a civilization that was locally colored by the varying conditions of existence, but retaining enough of its original character to show that it was all an outgrowth from a common root.

If this was the history of our Mexican and Peruvian civilization, its original founders must have belonged to the same general stock with those who built the architectural monuments of India, and erected in the island of Java those wonderful temples now buried in the forests, and in ruins.

Still, the time of separation must have been so remote, and the culture of the period so low, that each form of civilization grew up independently of the others, and they now show little relationship.

It is the opinion of geologists that a great continent once occupied portions of the present areas of the Indian and Pacific Oceans—a continent to which they have given the name Lemuria—and it is speculated that this was the cradle of the human race.

Be that as it may, from this section of the earth the brown Polynesians, Malays, Tahitans, Sandwich-Islanders, and Maoris spread, carrying with them characteristics and faculties which might very well be developed into a civilization such as that found on this continent by the European whites; and there is direct and collateral evidence that they sometimes landed on our shores.

Considering the balancing probabilities, I may say that it seems to be most probable that the west coast of America was

colonized from that source, and that the development of great and cultivated nationalities was the result of ages of quiet residence in countries which favored by their climate and resources the special phase of development which we here find recorded.

As to the date of the planting of the first seeds of this civilization we can only say that it is lost in the obscurity of the past. Everything indicates that some of the monuments in the category we have reviewed are among the oldest records of the human race; and it is certain that the gradual growth and spread of this civilization, the long noonday of its maturity, and its progressive decadence—which began long before the advent of the Europeans—must be measured by thousands of years. Thus it will be seen that in antiquity this indigenous and peculiar American civilization takes rank with that of the Egyptians, Assyrians, Hindoos, and Chinese, and in respect to culture, numerical importance, and territorial area will bear comparison with either.

WHAT ARE DIATOMS?

By EMILY L. GREGORY,
OF BARNARD COLLEGE.

SINCE the microscope has become so familiar in our homes and ordinary places of resort, many terms are frequently heard which have an unfamiliar sound. For example, a lady asked the other day, with a laugh over the open confession of ignorance: "What are diatoms? I hear the word used very frequently, and with such an air of acquaintanceship and familiarity, that one must suppose they are the most common, every-day affairs, and yet I must confess I have never seen one and don't know really what they are."

Thinking possibly there might be others interested in a brief description of this curious plant, the following story is told of a visit paid this summer to a gentleman said to know *all* about diatoms. The plants in question are so small as to be seen only with the aid of the microscope; those of ordinary size, when magnified about three hundred and fifty diameters, appear about a quarter of an inch long. Others are much larger. They are curious little plants with a silica shell, which, in certain places, is provided with little apertures through which living parts of the plant protrude. In this way they are enabled to move about freely in the water by which they are generally surrounded, for, though they are not all strictly water plants, they all need considerable water to enable them to thrive, and so are always found in wet places.

Owing to their freedom of motion they were at one time supposed to be animals. Now it is known that they are plants, as they can perform all the functions of plants, and no animal, with all his superiority, high nature, etc., is able to do this. They are found everywhere in all inhabited countries, and in fact all over the seas, so it may be readily granted that a plant so common and wide-spread as this should be quite familiar to every one.

Again, not only are the living plants so wide-spread and common, but the shells of the dead ones remain intact for many years; and in certain localities these tiny shells are so numerous as to form a large portion of the soil. Some of the best known of these localities are the sites of Richmond, Va., and Berlin in Germany. It is often said that the city of Berlin rests on a foundation of

FIG. 1.—PLEUROSIGMA FORMOSUM.

FIG. 2.—PINNULARIA MAJOR.

FIG. 3.—STAURONEIS PHŒNICENTERON.

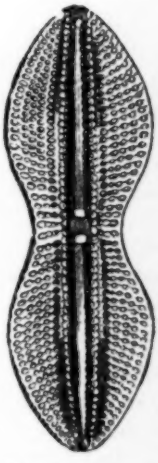


FIG. 4.—NAVICULA DIDYMA.

diatom shells. The little plant dies and decays, leaving the shell, which retains its shape for many years. These cells are most beautifully marked with very delicate tracery. No tools can be made to perform such work as this. Some shells with the most regular forms of markings are used for testing lenses, such as *Pleurosigma*, shown in Fig. 1. Some of the most common forms are represented by Figs. 2, 3, and 4, while another less frequent and with more curious markings is shown in Fig. 5.

Now, though it is so easy to obtain large numbers of these plants—only a spoonful of mud from the bank of a stream or edge of a pool, a bit of sea-weed thrown up on the shore will contain

thousands of them and a great many different forms—though it is quite easy to find them almost everywhere, it is still very difficult to make out their manner of existence. For example, how they perform the feat of locomotion is not well understood. There are two ways of explaining this: one is, that the diatom moves from place to place, owing to the osmotic changes constantly taking place inside the shell; the other and perhaps better authenticated opinion is connected with the peculiarity already referred to—that is, the presence of little apertures in the wall through which portions of the protoplasmic contents protrude. Those who believe in the osmotic theory claim that no such apertures exist, and consequently no protoplasm finds its way to the outside of the shell. In connection with this point comes the story of the visit.

FIG. 5.—STICTODISCUS CALIFORNICUS.

While working in the Botanical Laboratory of Berlin this past summer, the writer was invited to visit a gentleman having the reputation of knowing more about diatoms than any other person now living. It is rather a strange fact that this gentleman is not a learned professor who has spent a long life over scientific problems, but a retired book-seller who owns a beautiful villa in the suburbs of Berlin, and has for many years been gathering information of various kinds about this wonderful little plant. He has nearly all the literature treating this subject, several large volumes of which are now out of print, and for which he told me he had been obliged to pay exorbitant prices.

Before proceeding to the inspection of the laboratories, specimens, models, etc., coffee and cakes were served in the garden, a distinctively German hospitality which no scientific interests are allowed to interfere with. We then began in the preparing laboratory, a small but very completely fitted room, where the material for investigation is stored, treated, and classified for use. Here are the chemicals used in preparing the plant for examination. Some processes serve to preserve the form and general structure of the living part within the shell, so that this may be studied; other reagents, on the contrary, destroy the living portion, whereby the shell may be more easily examined. In this laboratory was a microscope of somewhat older style than our recent ones, but a very good, reliable instrument, which he told me

he used in the coarser manipulations, but, owing to the presence of chemicals in this room, none of his finer instruments were kept here. He explained his methods of treatment in clearing the soil and dirt from the land specimens, and also showed me the little silk nets which he uses when fishing for the water forms. Certain kinds grow only on the surface of the sea; so, to collect these, it is necessary to go out in a small boat and row very slowly, for the cloth of which the net is made must be very fine in order to prevent the escape of the tiny plants through its meshes. Owing to this extreme closeness of the meshes, the water drains through very slowly. The form of the net is quite like those used to catch butterflies, but is held with the handle up and close to the boat. At very short intervals of time it must be taken up and the water poured out; the inside of the cloth is then carefully rinsed in clear water, which is kept in a jar or bottle for that purpose. The most difficult part of the process is to row slowly and steadily enough to prevent tearing the nets.

These diatoms found on the surface of the water are furnished with long arms or projections, from which protrude hair-like bodies, which apparatus he conjectures is for the following purpose: One means of deciding that this little organism is a plant, is that it performs the function of assimilation, as it is called, by which it gives out oxygen. Now, this gentleman thinks the little hair-like outgrowths are for the purpose of holding the oxygen in their meshes so as to enable the plant to float.

FIG. 6.—LIVING DIATOMS: *a*, Cocconema lanceolatum; *b*, Bacillaria paradoxa; *c*, Gomphonema marinum; *d*, Diatoma hyalina.

After looking through this room and learning as much as possible about his methods of treatment, we went into another much larger and more elegantly furnished apartment, where all the nice and delicate work of studying forms and making models was done. Here were kept the books, all that have been written on this plant, and they filled a case of considerable size; also a very complete collection of microscopical apparatus. All that modern artisans can do in the way of fine and delicate instruments may be found here. Nothing less than the best oil-immersion lenses can be used in the study of form necessary to understand the inner structure of these plants. Several models have been made by this gentleman, and he told me of the

hours of patient labor which it cost to bring out so much as one little turn of the inner canal whose windings hold the living and active part of the plant, and also the explanation of the manner in which it moves. He has studied the mechanism of several forms and made models of plaster of Paris, and others of wire.

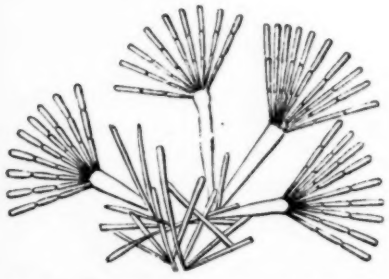


FIG. 7.—ECHINELLA FLABELLATA, a fan-like marine diatom.

Pinnularia major (see Fig. 2) is the plant from which the most conclusive results were obtained, and he claims to have demonstrated the existence of apertures on the surface of the shell through which the protoplasm may protrude. He does not, however, claim to have actually seen the protoplasm on the outside of the shell, but holds that, according to other known facts, it must be forced out, though in very small quantities. These apertures do not open directly into the interior, but by a series of winding canals whose action prevents the too easy expulsion of the contents. The movement of this protoplasm along the lines between the openings causes the movement of the diatom in a similar manner to the action of the fins of fishes. All this labor, after all, has reference only to a certain class of these plants; there are many others of such different forms that much study will yet have to be expended on them before their secrets are laid bare.

There are some curious little forms which grow in clusters on stem-like bodies which are often fastened by their other extremities to some object in the water. Some of these are shown in Figs. 6 and 7; and, finally, a variety of miscellaneous forms may be seen in Fig. 8.

There are large collections of these plants in nearly all the large herbaria of Europe, and the manner of preparing them for such collections may almost be said to form a special branch of industry. Experts are able to mount and arrange in order hundreds of these little organisms under a circular cover-glass of about five eighths of an inch in diameter. The dexterity which these experts acquire in the use of instruments is something almost as marvelous as the organisms themselves. It must be remembered, however, that this mechanical labor has nothing to do with the work of the scientist who studies the plant. It would be impossible for an investigator to give enough time to enable him to acquire this skill. A gentleman in Wedel, Holstein, has acquired a great reputation in this kind of work, and has plates holding from four to sixteen hundred different forms. These cost from twenty dollars upward, and he has recently finished a plate

on which are mounted four thousand diatoms, with which there is a printed catalogue. This single plate is the result of four years of continued labor, and the price he fixes for it is twenty thousand marks, or about five thousand dollars. I inquired if there was any probability of the owner selling such an expensive collection, and he said very quickly: "Oh, yes! Some rich English or American gentleman will probably purchase it; no German ever will." According to some of the latest systematic

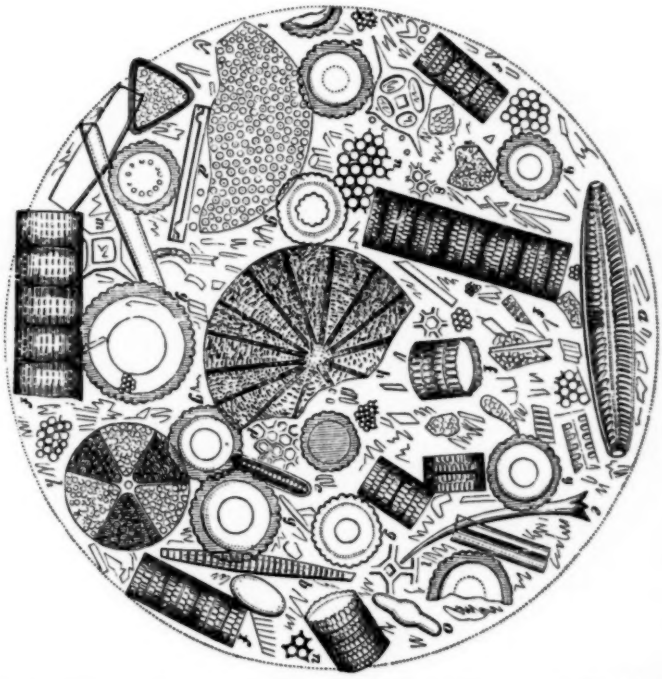


FIG. 8.—MICROSCOPIC VIEW OF RICHMOND INFUSORIAL EARTH. (By Ehrenberg.)

authorities, there are about eight thousand different species—so this plate may be considered as representing half of the known species.

It may be doubtful whether this story will help relieve the embarrassment of those who do not exactly understand what a diatom is. It serves to show, however, that very few people do know all about it; and this, together with the thought that it is considered of sufficient importance to warrant spending years of patient labor over it, will surely prove a consolation to those who have been puzzling over the meaning of the word.

THE RELATION OF BIOLOGY TO SOCIOLOGY.

By Dr. LEWIS G. JANES.

IN the preface to his recently published volume on Justice, Mr. Herbert Spencer newly emphasizes his conviction of the importance of the bearing of biological laws upon the study of sociological phenomena. Comparing the method of his present work with that of Social Statics, which covered a similar field of discussion, he asserts that "whereas, a biological origin for ethics was, in Social Statics, only indicated, such origin has now been definitely set forth; and the elaboration of its consequences has become a cardinal trait." The influence of this conviction is everywhere observable throughout the work.

It is not the purpose of the present writer, however, to discuss the applications which Mr. Spencer has made of this principle, except incidentally; but rather to reaffirm its importance, and to call attention to certain inferential dangers which spring from an unqualified acceptance of the conception that there is an entire identity of principle between the laws of social and organic growth.

While it is my firm conviction that Mr. Spencer has in no way exaggerated the importance of recognizing the bearing of biological principles in the study of societary evolution, it is equally important to guard at the outset against a fundamental though common misapplication of the analogy which would lead to results entirely divergent from the actual trend of social progress, as bearing upon the true scientific relations of the individual to the state.

On the one hand, it is undoubtedly true that nearly all our writers upon sociological, ethical, and economic topics are insufficiently grounded in a knowledge of the scientific method as revealed and illustrated in the physical and biological sciences. Their arguments rest largely upon an *a priori* and metaphysical basis of reasoning. They treat man as a being dissevered from the world. They fail to recognize the fact, demonstrated by the triumph of the doctrine of evolution, that man is one with the universe; that he can not be studied apart from his connection with the laws and principles which govern the physical world and the vital activities of the lower organisms. It may not be necessary for the sociologist, moralist, or political economist to be a complete master of physics and biology in all their branches —life is too short for such a preparation; but he should at least be sufficiently acquainted with these sciences to be thoroughly conversant with the scientific method of investigation, the tone and temper of mind requisite in the investigator, and have a

general understanding of the laws and processes of biological growth as they are related to and distinguished from those exemplified in the evolution of inorganic structures.

On the other hand, theorists of the socialistic school have eagerly seized upon the assertion made by evolutionary writers that "society is an organism," and, by exaggerating the analogies between social and biological processes, have thence logically deduced their own doctrine of the supremacy of the state over the individual, claiming for it scientific and evolutionary sanction. Though Mr. Spencer has carefully guarded himself against this misapprehension, and his own philosophy of society is diametrically opposed to that of socialism, it is often claimed by writers of this school, and even by those who are of quite another way of thinking,* that it is only by a breach of logical sequence that he escapes socialistic conclusions.

Mr. Spencer, however, early noted the important fact that society differs from the higher products of biological evolution in that no social sensorium is discoverable; and in Justice he reaffirms and emphasizes this distinction in discussing the nature of the state. "The end to be achieved by society in its corporate capacity—that is, by the state," he declares, "is the welfare of its units; for the society having as an aggregate no sentiency, its preservation is a desideratum only as subserving individual sentiencies." He subsequently repeats this statement with renewed emphasis, evidently regarding it as of great importance.

In organic structures the unit or cell exists for the sake of the completed organism; its individual sentiency, if it possesses such a psychic quality, is subordinate to the sentiency of the organic whole. In society, however, the fact is the reverse: the social organism exists for the sake of the individual, or social unit. This relation of the individual to the social structure is one unquestionably which should be borne in mind and given its due weight in the application of biological analogies to the solution of the problems of society. Mr. Spencer's recognition of it completely absolves him from the logic of socialistic conclusions.

The resemblances between social and organic structures, however, are more notable and important than their differences, and are recognized not only by philosophical students of society, on the one hand, but also by eminent biologists on the other. Prof. Haeckel, speaking of the structure of animal tissues, says: "All the numerous tissues of the animal body, such as the entirely dissimilar tissues of the nerves, muscles, bones, outer skin, mucous skin, and other similar parts, are originally composed of cells; and the same is true of the various tissues of the vegetable body.

* Cf. Mr. George Gunton, in The Principles of Social Economics, pp. 298–310.

These cells . . . *are independent living beings, the citizens of the state,* which constitutes the entire multicellular organism."*

Again, he declares: "Every cell is an independent organism. . . . It performs all the essential functions which the entire organism accomplishes. Every one of these little beings grows and feeds itself independently. It assimilates juices from without, absorbing them from the surrounding fluid; the naked cells can even take up solid particles at any point of their surface, and therefore eat without using any mouth or stomach. Each separate cell is also able to reproduce itself and increase. The single cell is also able to move and creep about, if it has room for motion, and is not prevented by a solid covering; from its outer surface it sends forth and draws back again finger-like processes, thereby modifying its form. Finally, the young cell has feeling, and is more or less sensitive."†

Elsewhere, even more pointedly, he affirms, "The many-celled organism is ordered and constituted on the same principles as the civilized state, in which the several citizens have devoted themselves to various services directed toward common ends."‡

Both biology and sociology treat of the phenomena of life; both involve psychological as well as merely physical conditions. In the natural order of the sciences the one leads up to the other by an inevitable sequence. There is a similarity in the processes of growth between biological and sociological structures which is noteworthy and most suggestive. Inorganic substances grow by simple accretion, or addition to their bulk. Their growth is involuntary, and is chiefly determined by the operation of external forces and conditions. Organic substances, on the contrary, grow by intussusception—a process of waste and repair initiated and carried on in the individual cells or structural units throughout the internal constitution of the organism; and their growth is mainly stimulated by internal, volitional effort. In this respect, as I have elsewhere argued, "the growth of societies resembles that of organic substances; it is a sort of vital chemistry."# The individual in his relation to society resembles the cell in its relation to the vegetal or animal organism. The death of individuals, and the birth and growth of others to fill their places in society, proceed in like manner with the processes of waste and repair in organic structures.

In the biological structure, however, the attractive forces which bind atoms into cells and cells into an organic unity are molecular and physical. In the sociological structure they are functional and psychical. And herein, I think, lies the explana-

* Evolution of Man, vol. i, p. 60. † Ibid., p. 131. ‡ Ibid., pp. 149, 150.
# The Scope and Principles of the Evolution Philosophy, p. 22.

tion of that difference between these structures to which Mr. Spencer, Mr. Fiske, and others have called attention.*

As to the essential nature of those purely physical forces which we call attractive—e. g., gravitation, cohesion, and chemical affinity—we really know nothing. We know these forces only through their observed effects; and their "laws" which we deduce from repeated observations of these effects are merely our subjective classifications of orderly recurrent phenomena and their recognized conditions. In regard to sociological phenomena, however, we have an additional source of information. We can study the attractive forces which bind society together, not only in the secondary relation of their observed effects, but also in their primary relation, as movements of our own thought. Affection and self-interest are thus seen to be the attractive forces which bind society together, and these forces are consciously directed and made steadily operative solely by individual volition. Therefore it is that in its psychical aspect—the aspect directly involved in all measures of social advancement—society is subordinated to the individual, the structure to the unit, instead of the reverse, as in the evolution of animal and vegetal organisms.

All actual and permanent expansion and integration of society proceeds from the voluntary, co-operative action of individuals. The social reformer, therefore, who would work in harmony with the tendencies and laws of Nature must direct his efforts toward convincing the judgments and influencing the motives and moral natures of individual men and women, rather than toward forcibly changing the customs of society by legal enactments, official *pronunciamentos*, or majority votes under the white heat of an emotional political campaign. All of these popular and customary agencies of political action are doubtless of some service as educational influences, inciting thought among large classes of people who would otherwise remain passive puppets or unreflecting adherents of conventional social customs; but as means of finally solving and disposing of social and political problems they are lamentable failures.

It is strange that our socialistic reformers, who advocate the cure of societary ills by legislation and the paternal control of the Government over the affairs of the individual, do not see that men and women must first be personally convinced of the utility of such public arrangements as they advocate, with substantial unanimity, before legislation in their behalf could possibly be effective. And when the practical unity of sentiment has been wrought out in the community which would insure the enforce-

* The Doctrine of Evolution: its Scope and Influence. Popular Science Monthly, September, 1891, p. 592. Notably, also, Mr. George Gunton, in his Principles of Social Economics.

ment of the law, the law is usually no longer necessary. In other words, *voluntary consent* is the essential condition of all stable social arrangements, instead of governmental coercion.

It may be objected that the social philosopher is compelled to recognize that, under the law of relativity, arbitrary and paternal forms of government have had and still have their proper place in the order of societary evolution. They are adapted to certain phases of culture and civilization, wherein order could not be maintained under freer and more democratic governmental institutions. This is true; but such forms of government are always temporary and unstable, where the conditions of social progress are steadily operative. As populations attain to a higher degree of intelligence and culture, a larger freedom is demanded; and no arbitrary government can long resist this popular demand. The result of such resistance, when it is attempted, if not revolution, is stagnation, atrophy, and arrested development.

This principle of voluntary consent is well illustrated in the earliest and most primitive type of societary development—the family. The family is based upon the marriage relation; and while, in the savage and barbarous stages of human evolution, we have marriage by capture and the exercise of various modes of coercion sanctioned by custom and authority, it is universally admitted in all highly civilized communities that true marriage rests upon the uncoerced consent of both contracting parties. As this consent is less a matter of mere formality and becomes more perfect and complete, involving the recognition of attractions not only emotional and physical, but also intellectual, moral, and spiritual, so is the union more permanent and satisfying.

The principle herein laid down holds good in every stage of social combination, however complex and widely extended it may be. It is a sound political philosophy which is enunciated in that paragraph of our Declaration of Independence which affirms that all just powers of government rest upon the consent of the governed. This is as true of the older autocratic and monarchical systems as it is of our own democratic-republican form of government. An autocracy which finds no response in the hearts of the people, but is maintained solely by the iron rule of external compulsion, is a tyranny, unstable in its foundations, unadapted to its societary environment, and destined to early destruction, either by peaceful evolutionary measures or by forceful revolution. In such a state, nihilism and anarchism are natural products of the existing social conditions. The pent-up forces of an artificially restrained individualism must somehow find vent, even if it be by means of revolutionary violence. Russia to-day offers an instructive example of the truth of this principle.

The object of the social reformer should be, not only to accomplish the renovation of society, but to do it in the quickest possible time in which it can be so accomplished that the changes effected shall be permanent, and the trend of social evolution shall surely be directed toward the ideal end of individual enlightenment and liberation and social integration. These ends can be surely accomplished by the method of evolution; they are as surely retarded and indefinitely postponed by the methods of anarchical violence and artificial compulsion. The individualism fostered and aimed at by the evolutionary method should be sharply distinguished from that destructive anarchism which aims at the sudden and forceful abolishment of existing institutions.

Here, too, biology offers us a wise suggestion. Galton's law of "reversion toward mediocrity" shows that those biological changes which are suddenly effected by artificial selection and forcible deviation from the main trend of natural evolutionary tendency are not permanent. They endure only so long as the organisms are kept under the direct and active influence of the artificial conditions which produced them. The moment they are left to the unrestrained operation of purely natural forces, they speedily revert to their original status. This must be the case in sociological evolution also, whenever social and institutional conditions are artificially forced, in advance of the intellectual culture and functional development of the masses of the people.

The history of our own time is full of instructive examples illustrative of this sociological law: of innumerable co-operative experiments, ideal communities, and the like, that have arisen, obedient to philanthropic impulse, enjoyed a brief, precarious existence, and died for want of sustenance; of artificial commercial situations, the product of legislative interference with the natural laws of trade, which induce at first a feverish appearance of prosperity, followed by great fluctuations in values, and finally by panic and financial collapse. As artificial conditions thus established are always liable to be suddenly modified or annulled by variations in popular sentiment, the progress of discovery and invention, changes in governmental administration and administrative policy, the influx of foreign elements into the population of a given locality, and a thousand and one other causes, temporarily or permanently operating, it should manifestly be the purpose of the wise social reformer *to build along the great lines of natural evolutionary tendency*, and thus to make use of those elemental forces, social, moral, and biological, which will insure stability and permanent prosperity for the results of his efforts.

He will thus aim to encourage voluntary co-operation instead of an enforced regulation of society by means of legislative en-

actments. The success of this aim will, of course, depend upon the intelligence and moral development of the citizens of a given community. The liberation of the individual—his increasing ability to secure the satisfactions consequent upon the free and orderly use of all his faculties—will proceed *pari passu* with his increasing dependence on the co-operative labors of his fellows. The processes of social differentiation go on hand in hand with the tendencies to social integration. As occupations become more diversified, the individual acquires greater skill in his special vocation; he produces a greater amount of wealth, and thus conduces more to the well-being of society, as well as, under a properly regulated system of labor, to his own personal well-being. Fewer hours of labor are requisite to insure a livelihood, as labor becomes differentiated and automatic; more time may be bestowed upon general culture, social intercourse, and the service of the commonwealth—upon the development, in short, of that fullness of life which constitutes the ideal of a perfect manhood.

In wisely serving himself, the individual is thus rendering a greater service to society; and this, in turn, inures to his own roundabout development. Egoism is thus purged of its excesses, and made to promote the general well-being. This, in turn, conduces to the highest individual prosperity and culture. In the proper equilibration of egoistic and altruistic motives in the government of conduct, all conflict between these motives ceases. In wisely serving his neighbor man renders the truest service to himself, and *vice versa*. Thus society integrates by a natural process of growth, obedient to laws which are operative in the evolution of all living things; and its ultimate form constitutes a real brotherhood of consent, instead of a militant organization consolidated by external coercion.

WANTED—A RAILWAY COURT OF LAST RESORT.

By APPLETON MORGAN.

WHILE the debates in Congress which resulted in the passage of the act to regulate interstate commerce were in progress, and during the first few months of the enforcement and interpretation of that act, I contributed to The Popular Science Monthly a series of criticisms of that act and of its policy.

To me, and to thousands of others, the policy of the act seemed un-American and paternal; or, if not un-American and paternal, then a policy which could and should be applied to other than the transportation industry—to places of public amusement, or to professional pursuits, to the business of the physician or the law-

yer, or to hundreds of others. I pointed out that, if rigidly enforced, the act would amount to a confiscation of private property; since, if the investment of private capital in any business can be compelled to make charges for services in accordance with a tariff not framed with any reference to the capital invested or the value of the service rendered; or if the value of services can be estimated by the person served, and paid for only in accordance with his estimate, and without hearing from the party performing the service, the value of private property invested in plants used to render services to others than its owner would speedily disappear. In other words, the principle upon which the Interstate Commerce Act appeared to me to proceed was one which, if pronounced proper, would justify—and if rigidly enforced might even result in—the operation of all railways by the Government. But, however that policy might work in European countries, it seemed to me impossible of other than despotic and ruinous application in the United States with its five hundred railways, their vast united capital and their enormous aggregate of fixed indebtedness held in the shape of negotiable securities, and very largely held in England and upon the European continent. At least it seemed to me impossible without a peremptory, and so a paternal, fixing of values at which the Government should acquire the railway road-beds and plants, not to mention the creation of a tremendous civil list, which in itself would probably precipitate the very evils and tyrannies which the socialists and alarmists foresaw from the private ownership of railways, and the consequent accumulation of occasional private fortunes beyond the actual appreciation of services of the employments of capital.

The Interstate Commerce Act has now been in operation about four years. Its enforcement, so far from being rigid, has been marked by extreme leniency and enlightened judgment upon the part of the commission appointed to administer it—a judgment in which the echoes of public clamor or the verdicts of the market-place have found no recognition; and the result has been, it seems to me, an entirely unforeseen situation—one still more favorable to the railway companies and charitable to their procedure, if possible, than was the situation prior to the enactment of any Interstate Commerce law whatever. Before proceeding to demonstrate a few of the anomalies of this, from my own standpoint, entirely satisfactory condition of affairs, it is only fair to the railway companies to state that they, immediately upon the appointment of the commission, began to enforce the most implicit obedience to the letter of the Interstate Commerce law, and that—whatever diplomacy there may have been on their part—it has never resulted in the administration in a single case of the penal processes with which the commission was empowered by

the act to, in its judgment, follow up a recalcitrant railway company.

The inventors of the act of Interstate Commerce designed it to cheapen freights to the people by compelling railways to sharply compete, and to relieve the country from what were claimed to be discriminations, and to adjust local inequalities. They put the act upon the statute-book. But—by a strange deliverance of affairs—none of these objects were accomplished. No sooner did the act become law than it operated to relieve the railways from competition, increased freights, and shifted, without lifting or adjusting, what were called "discriminations." But, while powerless to advance the objects for which its projectors had fondly drafted and urged it, the act did accomplish one great good—and one not local, as were the grievances, if any, it was framed to remedy, but a national and general good, which it is needless to say its framers and proponents never dreamed of subserving. That national good was nothing less than the appreciating of American railway securities in the European exchanges.

I am not exactly certain that the railway companies themselves foresaw this result when they yielded so prompt and unanimous an obedience to the Interstate Commerce Act, but it is indisputable that this acquiescence and obedience brought about this happy desideratum. It has not been unsuspected that, just as the past few years have seen the "Trust" devised by capital to meet and offset and checkmate the waste and unreasonableness of the labor-unions, so the railway companies, upon finding the popular opposition to them crystallizing into a Federal statute, by a single *coup* turned the statute itself into an ægis, and made it (as the old maxim says of the device of a mortgage) a shield as well as a sword. But, however this may have been, the immediate result was as I have said. The European investor, who had often looked askance at American railway securities, because he had somehow absorbed a notion that our United States railway companies were more or less unregulated by statute, and so more or less lawless, upon seeing them brought under Federal regulation (always with his old-time ideas of the paternal and constabulary benefits of government control), did not hesitate to bestow upon our railway securities the confidence with which he already regarded our Government securities. As I have said, it is an open question whether the railroad companies themselves foresaw this result; but it remains another and a very curious cumulative instance of how (as I have before noted) the Interstate Commerce Act worked upon the railway companies, much as the prophet Baalam is related to have worked upon the children of Israel. He was employed to curse them, but he blessed them superlatively.

But if the policy of Federal regulation of railroads is to be

permanent, it should be as perfect in operation and as nicely adjusted as possible; and to this end there are two details still desirable. In order that the subjects of the regulation, as well as its administrators, should be able to know exactly what is required of them: exactly what to expect, and be forever—the one as well as the other—confident that no rules and regulations, penalties or punishments, should be at any time "sprung" upon them, or be enforced by way of surprise; or without, as the phrase goes, that due process of law, "of which" notice "has been held to be the most essential part": it is necessary and vital that there should somewhere be and remain a court of last resort.

Now, the tribunal or office which we know as the "Interstate Commerce Commission"—with headquarters in Washington—is not a court of last resort, or, indeed, a court of any sort. It is nothing, indeed, but a referee or master-in-chancery, whose only authority is to find and report a fact or a state of facts. (This has been repeatedly held, not only by the lower courts, but by the Federal Supreme Court itself.) Moreover, this Interstate Commerce Commission has no power to award a judgment; or, if it does award a judgment, to enforce that judgment by process or execution. However penal in character its decrees may be, the summary process must issue elsewhere.

Assuming that the American principle that all government derives its charter from the consent of the governed has been satisfied by the obedience rendered to the provisions of the Interstate Commerce law by the railway companies, it follows that the railway companies are entitled not only to know exactly what is expected of them, but to know to what tribunals they are amenable in case of any future disobedience or inadvertence or misunderstanding as to the provisions or edicts by which they are governed. And, further, the governed are entitled to a single statute or set of statutes, and to a single tribunal or succession of tribunals, and to be relieved from the confusion of conflicting collateral statutes and collateral tribunals. If they, the governed railway companies, are not entitled to know just exactly what they are to do and what to leave undone, then they are entitled to the public sympathy rather than to the public surveillance; and, no matter what they do or leave undone, can plead such a conflict of collatera laws and of decisions and of decrees of courts as will leave it impossible for them to be guided by anything—in any given case—but their own sovereign discretion.

Is there at present such a state of affairs as renders the railways entitled to act upon their own sovereign discretion, equitably if not legally; and to plead mistake in case of an arraignment for any consequences or any result of such action? Remembering that the law of the land, the common law, was not written for rail-

way companies, who are only persons (or at the most common carriers in the eye of the common law), certainly they are entitled as persons that statutes passed to regulate them as railway companies should be definite, fixed, single, and certain. It is as abhorrent to justice that a corporation, or a railway corporation, as it is that a natural person, should be compelled by law to act at his peril. But the situation is exactly this: Anomalous and intolerable and abhorrent to justice as it may appear, our United States railway companies are compelled by law to act at their peril. For every single one of our forty-four sovereign States, and about all of the Territories, have copious and dictatory statutes concerning railways, and these statutes are in every case to be added to—not held appealable to or reconcilable with, but collaterally additional to—the Act of Interstate Commerce! And each governed and regulated railway company must either select some course of procedure which shall contain some three or four, some larger or smaller, groups of these State and Federal statutes, or else disobey one or more groups of them at its peril; or in almost every possible case presented to it for its discretion institute suit for a construction of all these statutes in each particular case, and carry it to the court of highest resort, the Supreme Court of the United States! Indeed it is only, as I have said, because the Interstate Commerce Commission has thus far been composed of gentlemen and jurists who have used the utmost personal judgment, conservatism, and leniency in administering the statute, that every railway company in the land has not been driven to one or the other of these procedures (and this not once but hundreds or thousands of times, almost daily, in fact), viz., either to flatly disobey, or else to maintain a suit up to the Supreme Court of the United States. But from the calmness and conservatism of a tribunal as once, at present or at any one time constituted, unhappily no warrant for the future or for any other time can be drawn. A change of *personnel*, always possible, might ingraft or enforce a new policy at a moment's notice, with what results nobody could predicate or prophesy. But one can always state that, in whatever form the result came, it would amount to an interruption of public business and of the course of commerce.

Now, there are two remedies for this state of things: one of which has been urged before, and by a no means inconsiderable or thoughtless or turbulent or revolutionary element of the population; and the other of which has been certainly suggested, though not, as I am aware, ever very seriously discussed. The first remedy is the purchase and operation of the railways by the Government; and the second is either the abolition of State railway statutes and of State Boards of Railway Commissioners, or else the making of the Federal Board of Interstate Commerce an appellate

court from the court of the State Railway Commissioners, thus either subordinating or conforming all State railway statutes to the Federal statute of Interstate Commerce, amending the railway statutes to the statute of Interstate Commerce in as far and as often as the same may be amended or altered or enlarged by the Federal Congress.

The first of these remedies—the Government purchase and operation of railways—I have so fully and at length discussed in these pages that it would seem superfluous to touch the matter further, unless the reasons then given to show that the project was impracticable and impossible (or, if practicable and possible, then unconstitutional) can be disposed of. I may briefly state that the principal of those reasons were: first, that the immense number of competing railways would make the operation of more than one of them between terminals an act of bankruptcy on the part of the Government (which would attempt to compete with itself), while to discontinue a competing road would be to deprive local stations of business facilities to which they would be entitled as well as the terminals; and, secondly, as above stated, that to operate the five hundred railways in the United States, or any considerable number of them, would necessitate a civil service so enormous and costly that, even if administered with the most rigid economy, it would absolutely and superlatively realize for this people the worst effects which the most hectic of the popular railway reformers have prophesied from the continuance of the present system. In addition to these practical objections the constitutional objection was, that the purchase of our railways would be impossible at present, whatever it might have once been, since no price at which the railway plants could be purchased could be arrived at. To purchase them at more than their value would be a robbery of the non-railway public; to purchase them at less than their value would be a robbery of the owners of the railways; while to purchase them at their exact value, admitting that it could be reckoned, would be in itself a confiscation (and so a robbery), as forcing innocent holders to relinquish such legitimate investments for their capital as they had lawfully seen fit to select.

As to the second remedy, there is, I think, something—indeed, a great deal—to be said in its favor, not only from the side of the railway companies, but from the side of the people of this country (from the shippers, as we may perhaps call the non-railroad operating population; of course, an enormous majority of the whole). And as to this I respectfully offer the following considerations, not in behalf of the railways, but of the customers of the railways.

Congress has more than once passed a national bankruptcy act, and, I believe, always with beneficial results. Moreover, I

think no sooner has a national bankruptcy act expired or been repealed, and the various State insolvency laws more or less taken its place, than the public credit has felt the change unfavorably, and the business interests of the community have clamored for the re-enactment or rehabilitation of the national statute. Now, if the Interstate Commerce Act stood alone, both the railway companies and the people would know exactly what was expected of each, independently and reciprocally. A codification of the procedure thereunder would place the whole simply at everybody's hand. The railway company would have no excuse for disobedience, and the aggrieved shipper would have not only his grievance but his remedy at his tongue's end. And not only would the shipper have a right to prosecute the company for disobedience or inadvertence or neglect or mistake, but the railway company might proceed against a recalcitrant shipper to compel him to obey the law: and this to the benefit not only of the railway company, but of his co-shipper or neighbor, to the quieting of all possible railway "discrimination."

If it is necessary in the present paper to demonstrate that as the Federal law stands, and as all these State and Territorial laws stand, neither of the great interests involved, neither the people nor the railways, can know where they stand, either independently or reciprocally, the demonstration is easily forthcoming.

To outline it as briefly as possible: At the appearance upon our statute-books of the act of Interstate Commerce, the art of railroading, in spite of all and singular the State statutes (some of them absolutely ridiculous, more of them unconstitutional, arbitrary, and penal, and almost prohibitive, and almost all of them inequitable to a large degree, as my prior papers have perhaps demonstrated), was rapidly approaching the state of an exact science. But, by the appearance of that act, this art or science of railroading was arrested and thrown back upon itself in a sort of "chaos by act of Congress." The enormous fixed or mortgage debts of the American railways—a large, perhaps the largest part of which was held in Europe (where, to a degree almost impossible to adequately describe to one not familiar with these matters, it involved the national credit itself)—had rendered the pooling system imperative. This pooling system had not been "sprung" by the railways upon the people, nor was it for the benefit of higher rates, or in the nature of a combination against trade, or of a "Trust." On the contrary, it had been evolved slowly—by long and costly experiments, and by extended deliberation on the part of the railway companies, and had expedited an absolute cheapening of freights, and a consequent impetus to manufactures, the reclamation of waste lands to agricultural purposes, and so had resulted in an unexampled—and

promised a still more enlarged—prosperity. Not only was it found impossible for the moment to equate rates, or to know what to charge the public for railway service, but among the railway companies themselves it was impossible to contract or hold each other to their agreements, covenants, or mutual obligations. Moreover, every or any insignificant local railway in the land (of five or ten miles long, or even of less) might and did solicit and accept freight to any point in the United States, Canada, or Mexico at arbitrary rates—deliver the freight at the end of its haul to other, and this to yet other, lines—so finally forwarding that freight to its destination at a rate absolutely prohibitive to a trunk line extending directly from the shipping to the destinative point of that very freight; and this from motives, not of competition, but of, say, jealousy, or looking to the depreciation of securities, and so of ultimate absorption, or control, or "wrecking" of the trunk line. Into this confusion stepped the State railway boards, each lending a hand, until for a time it seemed as if the business of railroading was about the most undesirable and unprofitable of employments not only, but a sort of punishment in itself. In short, it was as a last gasp, or a forlorn hope, that the railway companies, to save themselves, invented "pools," and begged acquiescence in them of the short local lines —in the hope of being able to earn their operating expenses, and possibly a prophetic fraction of their fixed charges. Imagine their consternation at an act of Congress which appeared and prohibited pooling!

What the railway companies or the national credit would have done, had it not been for the first important decision of the Interstate Commerce Commission (known as the Louisville and Nashville decision), it is impossible to conjecture. That decision, coming at the right time, declared that, while the text of the act forbade "pools" or "discriminations," or "the charging more for a short than a long haul," the spirit of the act was to do the railway companies as well as the shippers justice under the circumstances of each case. In short, that circumstances must control.

Under, I say, that benign decision, the railways have been able to exist and to prosper and pay their fixed charges. The "Gentlemen's Agreement"—nothing more or less than a series of "pools," called "associations"—only created by a sort of national instead of local consent (that is, by the principal railways acting as a unit instead of by groups of railways here and there—grouped by local or competitive considerations), has enabled the interest on American railway securities to be met abroad, and so the national credit maintained in the sensitive European markets, and all for the time has been well. The expense, to be sure, has been borne by the people—the shippers. There has been a uni-

form advance in freights. But this advance the people have felt was a small enough price to pay for the principle of Federal control of railways; and, as I say, the railway companies have acquiesced.

But, while the situation is just at present satisfactory, and while the railway companies, up to the present time, have been able to "pull through," it is impossible to deny that there is cause for considerable uneasiness, and indeed for considerable positive alarm, in the railway situation. It can not be too often repeated that the enormous mortgage debt of our five hundred American railway companies, averaging some fifteen thousand dollars per mile for some 200,000 miles of railway, being largely held abroad and payable in gold, most intricately and indissolubly controls our national credit. It must not be for a moment forgotten that the payment of the interest on this vast debt or loan is dependent upon the earnings of all this mileage, and that, if the shipper can not pay what the railway earns, this interest can not be paid. It is for these reasons that the subject of a conflicting Federal and State supervision of railways, and of their relations with the people, is of popular interest, and deserves discussion in The Popular Science Monthly, instead of being treated only in financial articles, which only reach the banker, the investor, and the capitalist. Nay, more, the direct interest of the people in the question of a collateral and possibly conflicting State and Federal jurisdiction over railway companies is even more immediate than as above outlined. Indeed, this direct popular interest can be traced into so many channels, each one of them ramifying into so many more, that one quite despairs of exhausting them within the limits of a single paper. Some of the more important of these channels may be, however, briefly indicated:

First, it is directly to the public interest: to the interest of each individual, capitalist, investor, or professional or working man, bread-winner or consumer: that values should fluctuate as little as possible, which is only another way of saying that capital should always be able to find remunerative investment. But (as shown before in these pages) if the capital now locked up in railways is not a remunerative investment, the next step is the railway bankruptcy, the stock-"waterer," and the railway-wrecker. Admitting, then, that the enormous fortunes, the accumulations of vast resources in the hands of one or two individuals—which was the constant argument of our Mr. Hudson and his ilk, and always is and always will be the argument of the communist and the anarchist—comes from stock-watering and railway-wrecking, it is the direct popular interest that our railway companies should earn their fixed charges. And to earn their fixed charges they must first, as we have said, earn their operating expenses: and to

earn these, or either of these, they must first of all be left in peace, and not at their peril to lawfully do all lawful business which comes to them.

A second ramification of this question of conflicting Federal and State laws may seem at first far-fetched, but on examination it will, I think, be found to be very intricately connected with the public interest. In the President's last message to Congress his Excellency says:

"I have twice before urgently called the attention of Congress to the necessity of legislation for the protection of the lives of railroad employés, but nothing has yet been done. During the year ending June 30, 1890, 369 brakemen were killed and 7,841 maimed while engaged in coupling cars. The total number of railroad employés killed during the year was 2,451, and the number injured, 22,390. This is a cruel and largely a needless sacrifice. The Government is spending nearly one million dollars annually to save the lives of shipwrecked seamen; every steam-vessel is rigidly inspected and required to adopt the most approved safety appliances. All this is good; but how shall we excuse the lack of interest and effort in behalf of this army of brave young men, who, in our land commerce, are being sacrificed every year by the continued use of antiquated and dangerous appliances? A law requiring of every railroad engaged in interstate commerce the equipment each year of a given per cent of its freight-cars with automatic couplers and air-brakes would compel an agreement between the roads as to the kind of brakes and couplers to be used, and would very soon and very greatly reduce the present fearful death-rate among railroad employés."

It seems to me that this passage brings us exactly to the question before us, for, while the President's recommendation is on the side of humanity, it is possible to see how considerable inequality and injustice might result from a carrying out of the suggestion. Even humanitarian laws are not always laws for the greatest good of the greatest number. For example, it might be asked, Why interstate railways only? (of course, in a message to Congress only interstate railways could be mentioned, as under its jurisdiction, though this is only true in a measure and not, as I take it, necessarily so)—and, if interstate railways only, how if State laws should also provide for the use of an automatic coupler, and supposing a State law should decree the use of one kind and the Federal law decree the use of another? Before the railway company could ask for a reconciliation of the two decrees, or even in good faith endeavor to provide an equivalent, how many litigants might arise to sue for a penalty under one law or the other, or how many railway accidents be added to the fatality list? And let it not be forgotten that, strange as it may appear, the enforce-

ment of the President's suggestion would actually work a hardship to the employés themselves by throwing thousands of them out of employment. (Of course, the hoary old question as to whether improvements in machinery in the long run do actually throw laborers out of employment might be discussed just here, but I fancy that while we were discussing it a great many brakemen might starve.)

If such a matter as this could be left by all the States, by unanimous consent, to the Federal power, and if, instead of so sweeping a law as the President suggests, a statute might be provided requiring the draw-heads of all freight-cars manufactured or admitted into the United States to be of a uniform height and to be within projecting frame corners from the rail surface, everybody can see that not only humanity but perfect justice both to the railway company and to the employé would be subserved.*

We are not at present discussing the question of automatic couplers; but this illustration shows: first, the necessity of a single and uniform railway law-maker, and that the law-maker should be guided only by expert knowledge and act only after adequate discussion and deliberation as to the best methods for not only preserving the lives of employés, but of conserving to them the opportunity of earning a living, and to the railway company the opportunity to earn the money to pay them their wages. It is certainly not necessary to go further into the subject already so fully discussed in these pages; but when the reader of former papers remembers the absurd and arbitrary laws passed by certain State Legislatures, such as prescribing the size and cost of station-houses, the number and distance even, without the slightest regard to the business or the earnings of the company, he will see at once how prohibitive of profitable railway enterprises (and so how perilous to the public, and even to the national prosperity) it may be, to leave all statutory control and regulation of railways in its present indifferent, undecided, and altogether chaotic state. It seems to me that it is the interest of the nation, of the public at large, of the railway companies, of their employés—in short, of all concerned—that such an adjustment may be arrived at as will secure, if at all, a Federal control of railways in the spirit of

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* I think such a law as this would be a better one than one directing the use of an automatic coupler, for it would not throw any brakemen out of their jobs. As to the loss of life spoken of by the President, the larger number of instances will, I think, be found to have occurred at night, when brakemen, not knowing of course the height of the draw-heads of the cars approaching them, and often while using every precaution, might be caught and crushed by a different build of car with flush corners, or higher or lower timbered corners. Such a law, prescribing uniformity in this detail, and mulcting the company owning the car or cars causing the death or mutilation with adequate damages, would be, I think, a salutary and an exemplary one.

the present Act of Interstate Commerce, by making that act superior to and controlling all State laws: at any rate, some single tribunal whose decisions may make a body of railway law for the protection as well as for the discipline of railway companies. If a possible dissenting voice should urge that there was a difference between a "State" and an "interstate" railway, I may add that it has been held repeatedly by the Interstate Commerce Commission, and never denied by the courts, that a railroad which is wholly within a single State, if engaged in the transportation of passengers and freight going to or coming from another State, is engaged in interstate commerce and is therefore subject to congressional control; and the Commission have repeatedly asserted, and are in this upheld by the highest authority,* that Congress may with respect to all the subjects of foreign and interstate commerce, the power engaged in, and the instruments by which it is carried on. It gives the power to prescribe the rules by which it shall be governed and the conditions upon which it shall be conducted. It embraces within its control all the instrumentalities by which that commerce may be carried on, and the means by which it may be aided and encouraged; and, if I am not in error, this power has been extended, by the present Interstate Commerce Commission, to the regulations and the workings and maintenance of a bridge over which freight having an interstate destination is transported! With such an interpretation of the constitutional clause, it would not seem to be going too far if the Commission should assume a veto power over the State Commissioners; and I am sure it would not be difficult to use it with the highest possible regard for the interests of all concerned.

One of the jurisdictions proposed for such a tribunal of railway last resort as I have suggested is that of restricting the construction of proposed railway lines by decreeing whether or not a proposed railway line is necessary or desirable between two given points. I think it is entirely safe to say, however, that no such jurisdiction will ever be assumed, or, if assumed, will ever be exercised by any tribunal or court within the United States. This people would resent (and no class of it sooner than that of men of the Hudson caliber, who see in railways the approaching cataclysm of the nation), as intolerable, the idea of any arbitrator—however lofty—deciding upon an individual's right to invest his own capital entirely as seemed to him good; but principally because such a power, if granted, would not be confined to a negative action alone. The right to forbid the building of a railway between two certain points would lead up to, and in time arrogate, the right

* 93 U. S., 103–114. Id., 196.

to decree the building of another railway between two other points; and as the one would be impossible, so the other would be absurd.

For all that is said about superfluous and over-railway construction, I confess that I would like to hear mentioned the one of our five hundred United States railway lines which is superfluous, or which the community which is served by it would consent to have torn up or to otherwise dispense with. I have myself cajoled, argued, and fought for rights of way, and finally brought condemnation and sundry other legal proceedings in order to construct a railway; but, once constructed, I think it would be dangerous to limb or life to suggest a discontinuance of that railway to the very people who once resisted, to their last extremity, its location.

The people of the United States are indebted to their railways in a sense which obtains in no other country on this planet. To say that the railways have turned forests into farms and made the desert blossom as the rose does not express this obligation. It is a greater one than that. To the United States as to no other nation the railways have brought wealth by a present realization of prospective revenues so enormously as to quite amount to an actual creation of values. In other countries railways have been built when populations demanded them, or could not exist longer without them—when great cities were to be brought together and great industries to be served. In the United States the railways have preceded and created the demand, the interests, the cities themselves.

The percentage in error of judgment is at least no greater in the promoting of railway enterprises than in any other branch of human procedure. Nor is it impossible to argue that even a forced railway construction—where actually no demand can be premised, no interests subserved, where no capital seeks legitimate investment, and no traffic exists, and for only ulterior purposes (such as "selling out")—is entirely a disadvantage to a community. Even the debentures of such a railway are not a public burden. For, while a promise to pay value is not perhaps a creation of value at the start, if interest be paid upon that promise and it is finally funded and ultimately paid in cash, it becomes a contribution to the public wealth (however meanwhile that promise or the guarantee of it may work criticism or prophecy of national ruin, or the elocution of the agitator or the communist about bloated or unhealthy private fortunes and the like). Large views and considerations of "the long run," do not, I think, warrant any paternal surveillance over private capital or the laws of supply and demand. What is wanted is either a surcease of railway commissions, Federal, State, and Territorial, in the United States,

or else that those tribunals which do exist be created into an intelligible succession, with one of last resort at the top, whose decrees shall be final to protect, as well as to discipline, both the railway company and its customers.

PESTIFEROUS PLANTS.

By Prof. BYRON D. HALSTED,
BOTANIST OF NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION.

SOME plants, naturally, are better fitted to subserve the wants of man than others, and for the growth of these he puts forth special effort; in short, the whole underlying foundation of modern agriculture rests upon methods of favoring these plants and thereby enlarging and multiplying those qualities in them that led to their being chosen by man as objects of cultural attention. All plants, therefore, that now legitimately occupy space in our fields, orchards, and gardens are living an unnatural life, because they are in part creatures of selection and care; and it therefore follows that, owing to this stimulus under which they have flourished for generations, when the fostering hand of man is withheld they either perish or gradually drift back to the wild state and slowly lose many of their most valuable qualities as cultivated plants and regain those that better fit them for the stern battle of life. During the time while cultivated plants have been brought to a high plane of usefulness there have been many other species with no merit in their products that have stood in the way of the development of these fostered plants. The weeds have grown strong because obliged to fight their way and take every possible advantage when opportunity offers. They quickly win in the race for supremacy in every field devoted to cultivated crops, when man's care is withheld, and multiply their kind to an extraordinary extent. More reasonable it would be to expect a man under the softening influences of civilized life to win in the rough race for existence when placed, unaided, among savage Indians, than to hope for the success of a parsnip or onion seedling when surrounded by a rank growth of weeds.

There is nothing in the structure of a plant that Cain-like curses it forever. No part of the leaf, stem, fruit, or flower gives conclusive evidence that it belongs to a weed, and therefore we are forced back to the definition that was accepted a long time ago, namely, "A weed is a plant out of place." Its relation to others makes a plant a weed. A rose bush of the rarest variety, and one highly prized in its proper place, is a weed when occupying the soil to the detriment of some other plant that has the

authorized right to the soil. Clover and the best of grasses may be serious weeds, fit subjects to be uprooted by the cultivator or hoe, when growing in a corn-field and injuring the maize crop. If a field is devoted to wheat, it follows that all other plants therein may be weeds, whether it be cockle, red-root, or an oak tree.

There is a possibility of any kind of a plant being a weed, but this thought does not prevent some species always being out of place. For example, there is no function in the economy of the farm garden that the Canada thistle can do as well as many other plants. As a forage plant, or a source of nutritious seeds or beautiful flowers, the pig-weeds are a substantial failure, equaled only by their success in occupying the soil and robbing it of nourishment designed for useful plants. It would puzzle any one to find a proper place for the horse-nettle, now advancing upon the Eastern farmers from the Southwest, and destined to spread its horrid, prickly, worse than worthless branches over our cultured soil. The bur-grass, cockle-burs, burdock, and a long list of congeners are practically universal every-day curses from which all earnest crop-growers wish to be free.

The natural covering of a fertile soil is a growth of vegetation. Upon the broad, open prairie there is a dense coat of grass, while in the Eastern States a heavy growth of trees clothed the virgin soil. So strong is Nature's desire to assert this right that if we allow one of our fields to lie fallow, at the end of the season it will be covered with vegetation. She understands that a bare soil is a wasteful soil, for while it is not producing anything it may lose by leaching much fertility already in its bosom. Every generation of plants inherits the deposits of all previous generations, and in turn should add to the accumulated stock in the soil. By this economical and saving practice of Nature the fertile newly broken grass lands have been made, while the upper soil in the forest has received the enriching accumulations of ages. Man overturns this harmonious system, and by breaking up the sod destroys the very method by which sod is made. He clears away the forest and many of the conditions which favor the growth of trees. It is upon this newly exposed soil that weeds assert their supremacy, and if the hand of man is withheld they will soon weave a garment, in itself unattractive, that clothes the bare earth. Weeds have a thousand ways of doing this to one possessed by cultivated plants. Bring up, if you please, some soil from the bottom of a newly dug well, and if exposed for a season some weeds will have planted colonies upon the bare heaps and vied with each other for the entire possession of the new territory, at the same time gaining in forces for the occupation of any similar place elsewhere.

The crop-grower necessarily introduces the condition of a bare soil for a portion of the year for every crop, and must therefore accept the situation: while he invites their presence and development, even stimulating them in various ways by making the conditions favorable for the growth of his crop plant, he must become a competitor with the weeds for the possession of the soil. The weed seeds are either in the soil or soon find an abundant entrance, and if the way is clear the young pests are up and doing as with the morning sun.

Most of our weeds, like much of our vermin, have come to us from beyond the sea. Just how they emigrate in every case will never be known; some came as legitimate freight, but many were "stowaways." Some entered from border lands upon the wings of the wind, on river bosoms, in the stomachs of migrating birds, clinging to hairs of passing animals, and a hundred other ways besides by man himself. Into the New England soil and that south along the Atlantic seaboard the weed seeds first took root. Also the native plants, with a strong weedy nature, developed into pests of the farm and garden. Many of the native weeds are shy and harmless in comparison with the persistent and pugnacious ones that have like vagabonds emigrated to our shores. Why should it be that plants of another country not only find their way here, but after arriving assert themselves with a vigor far surpassing our native herbs? Dr. Gray, in writing upon this point, says, "As the district here in which the weeds of the Old World prevail was naturally forest-clad, there were few of its native herbs which, if they could bear the exposure at all, were capable of competition in the cleared land with emigrants from the Old World." The European weeds had through long ages adapted themselves to the change from forest to cleared land, and were therefore prepared to flourish here in the rich forest soil that was suddenly exposed to the sun and subjected to other new conditions by the felling of the trees. To go back of this we are not sure that the ancestors of some of our European weeds ever came from the forests, but instead were brought into the cleared-up lands from open regions in the early days of agriculture in the Old World. As civilized man moved westward, the weeds followed him, re-enforced by new native ones that soon vied with those of foreign blood. Not satisfied with this, these natives of the interior ran back upon the trail and became new enemies to the older parts of our land. The conditions favorable for the spreading of weeds have increased with the development of our country, until now we are literally overrun. Weeds usually as seeds, go and come in all directions, no less as tramps catching a ride upon each passing freight train than in cherished bouquets gathered between stations and tenderly cared

for by transcontinental tourists in parlor cars. "Weeds," Burroughs says, "are great travelers. . . . They are going east and west, north and south, they walk, they fly, they swim. . . . They go under ground and they go above, across lots and by the highway. But like other tramps they find it safest by the highway; in the fields they are intercepted and cut off, but on the public road every boy, every passing herd of sheep or cows, gives them a lift." They love the half-earnest tiller of the soil, and will crowd around his barns and dwelling, and flourish in his garden and fields so long as he favors them with slight attention to his crops.

The fact is patent that weeds are everywhere, and the best means need to be taken to resist their greater prevalence. In this warfare against them there is no weapon equal to a thorough knowledge of the enemy—that is, an understanding of the nature of these pests, their appearance in all stages of growth, methods of propagation, and dissemination of the seeds. This knowledge is much more highly appreciated in Europe than here. In Germany, for example, they have wall maps upon which the leading weeds are represented. Hung as these are upon the school-room walls, a child, simply from daily seeing these life-like colored drawings of the various pests, will learn their appearance and names. Some such method of instruction is needed in this country, by which the children who are soon to be our farmers and gardeners may become familiar with the troublesome weeds even in advance of their advent, that the proper means may be taken at once for meeting and destroying them. Editors of agricultural papers and professors in agricultural colleges yearly receive many letters asking for the simplest kind of information concerning many common weeds, thus showing the general lack of knowledge upon this important subject. To put a map of a dozen of the most destructive weeds upon the walls of every country school-house in the United States is a great undertaking; but if it were done, the next and succeeding generations of farmers would be the better able to carry on the work of extermination. There are a large number of farmers' clubs throughout the country, and a great deal might be done by hanging a weed chart upon the walls of these halls where farmers gather from time to time for mutual improvement and a better understanding of the ways and means of a more profitable agriculture.

Weeds have been neglected in more ways than one, and just so far as they are overlooked and left to themselves the greater will be the curse. As one looks over the premium lists of our thousands of county and State fairs one seldom sees a prize offered for the best collection of weeds. It seems incompatible with our fitness of things to have a good collection of anything that is bad;

and yet the fact remains that there is no class of plants about which an increase of knowledge is more imperative than these same ugly weeds. A few dollars expended in awards by each fair association would bring together lists of plant pests the exhibition of which would not only surprise but greatly instruct those who see them. It is not less important for the farmers of any district to know of the arrival of a new weed than of the advent of a new fruit or grain.

In this connection, and in conclusion, it is a pleasure to announce that space at the World's Columbian Exhibition has already been set aside for a display of the weeds of the whole country, and preparations are now making for a full occupation of the allotment.

KOREAN MOUNTAINS AND MOUNTAINEERS.

By CHARLES W. CAMPBELL.

AS delineated on a Korean map of the country, the White Head Mountain seems to consist of a circle of jagged peaks inclosing a moderate-sized lake. The description of it in Chinese, in the letterpress department of the Atlas, recites that "Peik-tu San, or White Head Mountain, lies seven or eight days' journey to the west of Hoiryeng (a town on the Korean border), in Manchu territory. The mountain is in three tiers, is two hundred *li*, or sixty miles high, and the circuit of its base covers one thousand *li*, or three hundred miles. On the summit there is a lake eight hundred *li*, or two hundred and fifty miles in circumference, whence flow the three rivers Yalu, Sungari, and Tumen." These dimensions are greatly depreciated in Mr. James's description of the mountain in his book, The Long White Mountain. Nevertheless, lakes in mountain-tops seven or eight thousand feet above sea-level are rare enough to tempt the adventurous traveler to try to explore them; and this one on Peik-tu San yields precedence in interest, historically and geographically, to few others in the world. So thought Mr. Charles W. Campbell, of the English consular service in China, when, on the last days of August, 1889, he left Seoul on the tedious journey, by primitive Korean conveyances, of six hundred miles to the mountain. From his account of the journey, and the discussion it called forth in the Royal Geographical Society, are derived the facts given in this article.

The country traversed during the first four days of the journey was typical of the center and south of the Korean Peninsula. "Korea is a land of mountains. Go where you will, a stretch of level road is rare, and a stretch of level plain rarer still. The

view from any prominent height is always the same; the eye ranges over an expanse of hill-tops, now running in a succession of long, billowy lines, now broken up like the wavelets in a choppy sea, often green with forest, but just as often bare and forbidding. Clear mountain brooks or shallow streams rushing over beds of gravel are never wanting in the valleys below, where a rude long bridge, or curling smoke, or the presence of cultivation, leads you to observe the brown thatch of some huts clustered under the lee of a hill." On the fifth day Mr. Campbell "branched into untrodden country for the purpose of visiting a remarkable range called the Keum Kang San, or Diamond Mountain, where the most notable collection of Buddhist monasteries in Korea is to be found. There was a considerable change in the configuration of the land as we passed eastward from Keum-Seng. The valleys contracted into narrow, rocky glens, forests of oak, pine, maple, and chestnut clothed the steeper and loftier slopes, and cover sufficiently thick to delight the heart of the sportsman abounded everywhere." A pass too steep for laden animals had to be crossed with the help of bearers. It is known as the Tan-pa Ryeng, and is the western barrier of the Keum Kang region. "The summit is about twenty-eight hundred feet above sea-level. Thence in clear weather a view of the Diamond Mountains was said to be obtainable, and the name *Tan-pa*, which means 'Crop-hair,' was given to the ridge in the early days of Korean Buddhism, to signify that those who reached this point had taken refuge in the cloister, and should sever their connection with the world by parting with their hair.

"From Tan-pa Ryeng, a journey of sixteen miles in a north-easterly direction brought us to Ch'ang-An-Sa, or the Temple of Eternal Rest, a Buddhist monastery at the foot of the Keum Kang San (Diamond Mountains). These mountains are a remarkable section of the main range which practically determines the east coast of Korea. Elsewhere the aspect of the chain is tame enough, but in the north of the Kang-wen province it suddenly starts into a towering mass of irregular, precipitous rocks, whose appearance earned for them many centuries ago their present designation. Viewed from the Eastern Sea, which is not more than thirty miles off as the crow flies, their serrated outline is very striking, and must always make them conspicuous. The district they occupy is a fairly well defined one, some thirty miles long by twenty broad. Few places are more renowned in any country than these mountains are in Korea; in popular estimation they are the *beau-idéal* of scenic loveliness, the perfection of wild beauty in Nature. I found that both Chinese and Japanese spoke and wrote of them, but more because they are a Buddhistic center than for any other reason. At Seoul a visit to Keum Kang San is quite fashionable,

and supplies all the material necessary for reputation as a traveler. Buddhism evidently found a home in these secluded mountains soon after its introduction into Korea, which Chinese and native records tell us occurred in the latter half of the fourth century after Christ. A Korean book—the Keum Kang San Record—states that Ch'ang-An-Sa was restored or rebuilt at the beginning of the sixth century, and at the monastery itself tradition dates the oldest relics from the T'ang period (A. D. 618 to 907). At present upward of forty shrines, tended by three or four hundred monks, a few nuns, and a host of lay servitors, are scattered over the east and west slopes of the Diamond Mountains. The great majority of the monks are congregated at the four chief monasteries, and the nuns possess a small sanctuary or two where they find sufficient to do, apart from religious exercises, in weaving cotton and hempen garments and other womanly occupations. The monks, when not in residence at the monasteries, travel all over the country, alms-bowl in hand, chanting the canons of Buddha from door to door, soliciting subscriptions to the building of a new altar or for the repair of an old one, and begging from day to day the food and resting-place which are rarely denied them."

The route followed a rough torrent winding up the west slope to the water-shed—which is 4,200 feet above sea-level, and the highest point reached in the journey across Korea—and descended the eastern flank by a wild mountain-path. "The monastery of Ch'ang-An is superbly situated a little way up the west slope. The lofty hills which wall in the torrent on the north recede for a few hundred yards, and rejoin it again, leaving in the interval a semicircular space of level ground, upon which the temple is built. Nothing could be more effective than the deep-green setting of this half-circlet of hills, rising up like a rampart from the rear of the buildings, and rendered additionally pleasing to the eye by a symmetrical covering of leafy forest and shrub. In front, the water swishes and swirls through rough, tumbled granite blocks, here and there softening into a clear pool, and beyond this again towers a conical buttress of the Keum Kang San, thickly clothed with pines and tangled undergrowth for half its height. The peak possesses the characteristics of the range. Gaping seams and cracks split it vertically from the summit down until vegetation hides the rock, at sufficiently regular intervals to give one the impression of looking at the pipes of an immense organ. The topmost ribs are almost perpendicular, and gleam bare and blue in the evening sun; but lower down the cracks and ledges afford a precarious lodging to a few conifers and stunted oaks." The other mountains along the route occupy equally pretty situations. Soon after crossing the Keum Kang range, Mr. Campbell

struck the Japan Sea. A journey of sixty miles along the coast brought him to Wen-san, one of the ports opened to trade by the treaties with foreign powers. Hence he followed the coast-line northward for six days, passing through a number of populous towns, to Puk-ch'eng. Trade, which was not active on the Seoul-Wen-san route, was particularly stirring along the east coast. It is mainly in Manchester cottons. Fairs were common between Wen-san and Puk-ch'eng—as they are in all the populous districts of Korea. "The road was always animated with a concourse of merry, brightly dressed people, wending their way to the market town; women carrying jars and baskets of melons, pears, chillies, etc., on their heads, and babies on their backs; bulls and carts laden with brushwood for fuel; produce of all kinds, including grain and dried fish, borne by ponies and men; sturdy, half-nude coolies, perspiring under lofty, wooden frameworks, to which assortments of earthenware pots and turned wooden dishes are attached; and, more numerous than all, the pleasure-seeker, or *ku-kyeng-kun*, in holiday dress, strutting along in company with a batch of friends, gesticulating, laughing, and cracking jokes productive of the most hilarious mirth. Such throngs greeted the foreigner with amused surprise, sometimes a trifle rudely, but always good-naturedly. The women, in most cases, behaved as properly conducted Korean women ought to do when their faces run the risk of being scanned by a stranger, and turned their backs upon him; yet frequently all scruples vanished before an overpowering curiosity to take in the particulars of so odd a costume, or to discuss the singularity of the equipage. The main street of the town or village is the market-place. It often widens into a sort of place or square, where straw booths are hastily erected for the occasion; but, ordinarily, each man exposes his wares on some boards, or on a cloth spread on the ground in the best spot available. The articles for sale are of the simplest."

From Puk-ch'eng Mr. Campbell took the direct, across-country route through Kap-san, to Peik-tu-san, in preference to the more interesting circuitous route, because of the lateness of the season. Following the Peik-ch'eng River to its source, he then, next day, after leaving the city (September 24th), reached the crest of the range which here fringes the highlands of North Korea. The top of the pass, called Hu-ch'i Ryeng, is 4,300 feet above the sea; thence to the Yalu, at Hyei-san, a distance of a hundred miles, there was a gradual descent, with one remarkable irregularity, to an elevation of 2,800 feet. "The aspect of the country had completely changed. We had left some valleys producing rice and cotton, and had entered a plateau-like region, where these crops were impossible, their places being taken by oats, millet, and

hemp. At first our way lay through a forest of spruce, pine, birch, and oak, broken by an occasional marshy glade; to this succeeded an undulating country, which bore traces of being recently cleared. Clearings were made simply by setting fire to the forest—a process which I saw in operation. The population was scanty, but evidently increasing; the houses were log-huts, plastered with clay, roofed with thatch or shingle, and fenced with palisades of stakes six or eight feet high. Game hereabouts was very plentiful. . . . Tigers, leopards, and bears are also said to be easily obtainable. The tiger, indeed, is a fruitful subject of discussion. From Wen-san to Peik-tu San, and thence to Peng-yang, I heard endless stories of the brute's ravages, and more than once I was asked to delay my journey to shoot a 'man-eater.' In the Yalu backwoods I passed through a deserted clearing, where four out of a total of ten inhabitants, had become the prey of a man-eating tiger during the previous winter and spring." Large tracts of cultivated land became common near Kap-san; and the neighborhood is said to contain most of the mineral wealth of Korea; gold, silver, and lead being worked at several places, but with sorry appliances and little skill. There is no doubt that the country is rich in useful and valuable minerals, but it has yet to be ascertained whether they can be worked at a profit.

The first view of the White Head Mountain was obtained from the crest of the ridge overlooking the Yalu, about thirty miles north of Kap-san. "Its renown was at once comprehensible, for, distant as it was, the view was majestic. The white, irregular mass towered, without any marked or prominent peak, head and shoulders over the surrounding hills, though one could see that it was not lofty, as mountains go. . . . Just at the point where this mountain is first visible a small temple has been erected for the purpose of offering sacrifices, which is done by the King of Korea every year on the 4th of the eighth moon (August) to the Peik-tu San deities. At Seoul I was led to believe that the officials deputed to perform this function actually ascended the mountain, but they evidently preferred a compromise, the efficacy of which has apparently never been doubted."

The rest of the journey to the mountain, with only hunters' paths and blazes through the forest, which was made in the first days of October, was beset with difficulties on account of the wintry weather. The last settler's hut was passed, and after that the party had to depend on the hunters' huts, which had been deserted for the winter. When two or three miles from the end of the journey, the best guide who could be depended upon fell in a fit brought on by overexertion. The superstitious Koreans attributed his paroxysms to the malevolent *san sin*, or mountain

genii, and spent the night in offering prayers and propitiating sacrifices of rice to the offended deities, while Mr. Campbell doctored the man with Liebig's extract. The man had somewhat recovered from his disability, but in view of the discontent of his party, and the risk of going farther into the wilderness under the circumstances, Mr. Campbell made no further attempt to reach the top of the mountain.

This mountain, the Old White Mountain, as it is called by the Chinese of Manchuria, "is the most remarkable mountain, naturally and historically, in this part of Asia. The perennial whiteness of its crest, now known to be caused by pumice when not by snow, made the peoples that beheld it from the plains of Manchuria give it names whose meanings have survived in the Chinese *Ch'ang-pai Shan*, or Ever-white Mountain. This designation, obviously assigned to the White Mountain alone, has been extended to the whole range without apparent reason, for no other peak of it, so far as is known, can pretend to perennial whiteness, whether of pumice or snow. . . . The great point of interest in the mountain, apart from its whiteness, is the lake—twelve miles in circuit, according to Mr. James and his party, the only Europeans who have seen it—which lies in the broad top of the mountain at a height of 7,500 feet above sea-level, and is supposed to be the source of the three rivers, Yalu, Tumen, and Sungari. The *Tei-Tei-ki* (Great Lake), as the Koreans call it, is the nucleus of a mass of legend and fable. It is a sacred spot, the abode of beings supernatural, and not to be profaned by mortal eye with impunity. Curiously enough, neither Chinese nor Koreans have the faintest notion of the real character of Peik-tu-San. The Chinese say that the lake is an eye of the sea, and the Koreans tell you that the rock of which the mountain is composed 'floats in water,' for lumps of pumice were common on the Yalu at Hyei-san. My crude geological explanations, that this *cho-san* (ancestral mountain) of Korea was a burned-out volcano, whose crater had been filled with water by springs, were listened to with polite wonder and treated with less credulity than they deserved. I pointed to the black dust, to the clinkers, and to the rocks lining the banks of the Yalu for miles, many of which looked as if they had been freshly ejected from some subterranean furnace, but to no purpose. If the occurrences I had spoken of had taken place, they must have been handed down by tradition, and it was useless to cite lapse of time—Koreans are ignorant of geological periods—to people whose history extends as far back as four thousand years ago. According to my observations, most of the forest between Po-ch'm and Peik-tu-San grows on volcanic matter, which was without doubt ejected from Peik-tu-San during successive eruptions. The general inferiority of the timber hereabouts to that

of the rest of Korea led me to examine the soil wherever an uprooted tree or a freshly dug deer-pit furnished the opportunity. Beyond a thin coating of leaf-mold on the surface, there was seldom anything else than broken pumice, broken to the size of a very coarse sand. According to the hunters, this was the subsoil everywhere in the forest. . . . Nearing the mountain, we get the clearest evidence of the character and recency, geologically speaking, of the eruptions which spread this vast quantity of volcanic material over such a wide area. Ten miles due south of the White Mountain, the Yalu, now eight or ten yards broad and very shallow, flows between banks like a railway cutting, sheer, clean, and absolutely devoid of vegetation, for denudation was too rapid to permit the slightest growth. The sections thus exposed were often over a hundred feet in depth, and at one of the deepest portions I counted thirteen layers of black volcanic dust, all varying in thickness, and each separated from the layer above by a thin stratum of volcanic mold. So fine was this dust that the least breath of wind caught it and scattered it freely over the adjoining snow, to which it gave a grimy, sooty appearance. The forests of South Manchuria, though uninhabited now, were, we learn from Chinese records, the home of many races in ages past. The comparatively recent kingdom of Ko-ku-rye, which arose in the first century B. C., is said to have occupied the Ch'ang-pai Shan and the head-waters of the Yalu River." Very few, if any, traces of these ancient peoples are found now; but this is hardly to be wondered at, considering their low civilization and the temporary character of their dwellings.

Captain Younghusband, speaking to Mr. Campbell's paper, described the trip which he, Mr. James, and Mr. Fulford made to the mountain from the northern or Manchurian side in the summer of 1886. At the foot of the mountain they found some most lovely meadows covered with iris, lilies, and columbine, surpassing even those of Kashmir. "Passing on up through the forest, we came to the summit of the Ch'ang-pai Shan. Before us were two prominent peaks seen from the north side—there are really five all round—and between these the saddle. Arriving there, we expected to see a view on the other side toward Korea; instead of that, however, we saw, straight under our feet, this wonderful lake situated right at the top of the mountain. It was of the most clear deep blue, and surrounded by a magnificent circle of jagged peaks, ascending one of which I got a clear view of all this country, over which Mr. Campbell traveled later on. We saw through the forest the course of this Yalu River and the Tumen River, which both rise on the spurs of this mountain, and out of this lake flowed a small stream which eventually runs into the Sungari, perhaps the most important tributary of the great Amur River, which

flows along the southern edge of Siberia. . . . The whole of this country shows signs of a volcanic origin. There is no doubt that this mountain Peik-tu San was formerly a volcano, and that this lake is the crater of the volcano."

Mr. Campbell's narrative and the discussion furnished some pleasing pictures of Korean life and character. It is a curious fact and suggestive that the most conspicuous and seemingly the most lasting traces left of ancient Korean settlements are the strawberries. The beauty of the situations of the Buddhist monasteries was remarked upon. For centuries Buddhism has been under a ban in the country, and its followers, driven from the settled country to the mountains, have established their monasteries there, out of the way. In selecting the most beautiful retreats for the study of their religion, they have followed, said one of the speakers, the bent of Korean character. "These monasteries form hotels for those travelers in the country who take their delight in leaving town life, taking simple food, and traveling day after day, piping their way on the roads, rejoicing in the beauty of the country. I should think in hardly any country in the world the ordinary rustic takes so much delight in Nature as in Korea; when he goes with you up the mountains, and, on arriving at the top, you expect him to sigh as if nearly dead, he will expatiate on the beauty of the scene before him. In this love of scenery, as in many other points, the Korean differs greatly from his neighbors the Chinese."

The Korean hamlets are of two kinds, "the purely agricultural, and those which depend as much on the entertainment of travelers as on farming. The site of the agricultural village is a hill-slope facing the south. Over this, low, mud-walled, straw-thatched hovels, each standing in its own piece of garden, which is protected by a neat fence of interlaced stems, are scattered at random, and there is not much of an attempt at a street anywhere. Every house has its thrashing-floor of beaten clay, the workshop of the family. The stream which runs past the foot of the hill, or courses down a gully in its side, is lined with women and girls washing clothes with sticks instead of soap, preparing cabbages for pickle, or steeping hemp. Seen from a distance, these places are quite picturesque. The uneven terraces of thatch are brightened by the foliage and flowers of gourds and melons which climb all over the huts. In the gardens surrounding each house are plots of red chilli, rows of castor-oil plants, and fruit trees such as peach, apricot, pear, and persimmon. The roadside village, on the other hand, is generally a most unlovely spot. The only street is the main highway, which is lined on both sides by a straggling collection of the huts I have mentioned. Heaps of refuse, open drains, malodorous pools, stacks of brushwood for fuel, nude, sun-tanned

children disporting themselves, men and women thrashing grain, and occasionally a crowd of disputants—all combine to make it a very indifferent thoroughfare. Most of the houses are inns or eating-shops. The main gate of the inn leads directly from the street into a quadrangle bounded on two sides by open sheds, which are provided with troughs for the feeding of pack-animals, and on the other two sides by the guest-rooms and kitchen. The court-yard is often dominated by a powerful pig-stye, and littered with fodder or earthenware pitchers and vats." General agriculture is, however, not so elaborate and fruitful as in Japan and southern China. "The principal farm animal is the ox; in mid-Korea he is a splendid beast—hardy, tractable, and bearing a strong resemblance in build to our short-horned stock. A cane or iron ring, for which his nostrils are pierced when young, suffices to control him, and he is early accustomed to his constant work of load-carrying. Plowing is done with the ox; rarely or never with the pony. Dairy produce is unknown, or nearly so. Draught cattle and ponies are fed on coarse fodder and a boiled slush of beans, chopped straw, and rice-husks. The remaining domestic animals are black, hairy pigs, wily gaunt creatures, and horribly loathsome; wolfish dogs, possessing a surprising nose for foreigners; and fowls that almost equal their wild congeners, the pheasants, in powers of flight and wariness."

An incident which happened to Mr. Campbell during his journey—in which a woman by bullying and coaxing forced a party of unwilling bearers into his service—gave a fresh blow in his mind to the theory of the subjection of women in the East, and strengthened his opinion that "women in these parts of the world, if the truth were known, fill a higher place and wield a far greater influence than they are usually credited with."

In a paper read before the French Association for the Advancement of Science, on the Succession of Media inhabited by the Ancestral Series of Man, M. Fauvelle presented a genealogical table of beings in which, waiving the question of plants, he showed forth the successive development of animals, beginning in sea-water, continuing afterward in fresh water, then in moist and marshy soil, to reach a higher stage on dry lands. The beginning was the cell, which originated in sea-water, an aquatic medium; the climax was man, a product eminently aërian. M. G. de Mortillet, while he recognized the ingenuity and attractiveness of M. Fauvelle's system, suggested that, to put it on a solid base, it would be necessary to prove that sea salt existed at the time of the origin of life.

In a paper at the British Association on the worship of meteorites, Prof. H. A. Newton gave accounts of divine honors having been paid to meteoric stones in early times, and of myths and traditions pointing to such worship. Particular attention was directed to the indications of this cult that are found in Grecian and Roman history and literature.

DUST AND FRESH AIR.

By T. PRIDGIN TEALE, F.R.S.

EXCEPT in the case of museums, few serious attempts have been made to exclude dust from rooms, closets, cupboards, and drawers, to the contents of which, not infrequently, dust is simply ruinous. We allow dust to run riot among our things of value, and then go to considerable expense to render them clean again, only to start them on a fresh career of defilement.

Looked at in the abstract, is not our passive capitulation to dust incomprehensible? When I enter an office in a town and see the window-sills and papers dotted with soot, or go into a bedroom and see the toilet-table defaced with blacks, and know that the soot and the blacks need not be there, I can not refrain from asking how comes it to pass that we so patiently submit to such perpetual discomforts. You will doubtless reply, We agree with you as to the existence of the evil, but how is it to be remedied? My object is to offer some practical suggestions whereby you may so far mitigate and reduce the evils of soot and dust as to make them tolerable, perhaps even to lay down principles by which the evils can be annihilated in those instances in which the result to be obtained is worth the cost of achievement. For the practical purposes of every-day life it may turn out that we had better be content with approximate perfection, a condition of existence which compels us to be content with approximately pure water from a filter, and approximately pure air in our living-rooms.

If dust is to be kept out of any cavity, we must first find out why the dust gets in, in spite of good workmanship and accurate fitting. The reason is simple, ridiculously simple when stated, but, curiously, it has been little, if at all, thought of, and certainly hardly ever acted upon in practice. And the reason is this: Closets, cupboards, drawers, and boxes contain air; if the air were inelastic and never altered in volume, there would practically be no entrance of dust into these closed cavities. Unfortunately for our cleanliness, air is changing in volume incessantly. We are all familiar with the barometer, and most of us no doubt understand why the quicksilver rises and falls in the glass tube, or why, in the aneroid barometer, the index moves to right or left. Let us consider what these changes mean, and what they record.

When the air around us becomes condensed—shrinks into a smaller volume—it becomes heavier, puts greater pressure on the surface of the mercury, and makes it ascend in the tube; then the mercury is said to rise. When the air expands—swells into a larger volume—it becomes lighter, the pressure on the mercury

is less, the mercury sinks in the tube, and the barometer is said to fall. Therefore, every change of height of the quicksilver which we observe is a sign and measure of a change in the volume of air around us. Further, this change in volume tells no less upon the air inside our cases and cupboards. When the barometer falls, the air around expands into a larger volume, and the air inside the cupboard also expands and forces itself out at every minute crevice. When the barometer rises again, the air inside the cupboard, as well as outside, condenses and shrinks, and air is forced back into the cupboard to equalize the pressure; and, along with the air, in goes the dust. The smaller the crevice, the stronger the jet of air, the farther goes the dirt. Witness the dirt-tracks so often seen in imperfectly framed engravings or photographs. Remember, ladies and gentlemen, whenever you see the barometer rising, that an additional charge of dust is entering your cupboards and drawers. So much for the barometer, which is a very restless creature, rarely stationary for many hours together. But this is not all. We also have the thermometer. The temperature of our rooms varies daily—often considerably—between midday and midnight, and greatly between summer and winter. What does the thermometer tell us? Not less than the barometer does it tell of change of volume of the air, though it is probably not so rapid in its effect upon the air in inclosed spaces as is the change of volume indicated by the barometer. Many of you have seen a fire-balloon. The heated air, filling the balloon, expands, and becomes lighter than the surrounding air, and up goes the balloon, until, the source of heat having become exhausted, the contained air cools, contracts, becomes as heavy as the surrounding air, and down comes the balloon again. So, also, as temperature rises outside our cases, the increased warmth is slowly conducted to the air inside the case, which expands and escapes through the crevices. Then, when the time for cooling comes, the air inside slowly contracts, and back rushes the air through the crevices, and again in goes the dust. Thus, we see we have two factors constantly acting, one or other tending to produce daily, nay, hourly, changes in volume of our dirt-carrying air.

In order to inform myself of the amount of change of volume that could, under extreme conditions, possibly take place, I asked Prof. Rücker to kindly calculate for me the change of volume that would take place in one hundred cubic feet of air, between a temperature of 30°, i. e., just above freezing-point, in combination with the barometer standing at thirty inches, or about "fair," and a temperature of 60°, combined with the barometer standing at twenty-nine inches, or "stormy." He told me that the difference would be about ten cubic feet, or one tenth; in other words, that

a closed case of one hundred cubic feet, if hermetically sealed at a temperature of 30°, with the barometer standing at thirty inches, would have to resist the pressure equivalent to the addition of ten cubic feet, when the temperature rose to 60°, and the barometer fell to twenty-nine inches. Have we not now discovered the reason why dirt enters closed spaces? What shall be the remedy?

Seeing, then, that air will find an entrance, and in the nature of things must get in—well, we must let it in, not at innumerable uncovenanted small crevices, but at our own selected opening, specially provided. Then we are in a position to strain off the dust by providing the selected opening with a screen, which acts as a filter. These, then, are the general principles on which we must act. The rest is a question of detail. The details range themselves under three heads: 1. What is the most effective, or the most generally applicable filtering material? 2. Given the filtering material, what ought to be the proportion between the area of the screened opening and the cubic contents of the case to which it has to be fitted? 3. What, in any particular instance, is the best situation for the filter?

What is needed in our filtering material is that it shall readily allow air to pass through, and shall also possess the quality of arresting in its meshes fine particles of dust. For some purposes it may suffice to use a coarse canvas, the threads of which are not too closely twisted and have an abundance of fine fibers projecting from them, thereby reducing the small squares of the woven texture to a still finer mesh. The material I have used most frequently is "bunting," but it has disappointed me. When examined by the microscope many of the small squares of mesh are seen to be deficient in delicate fibers standing out from the threads, which would enhance the filtering power of the texture. Lately I have tried other materials, domette, flannel, and cotton-wool between layers of muslin, such as is used for dressing wounds under the name of Gamgee tissue. Cotton-wool is probably the most perfect filter. Indeed, so perfect is it that in the new science of bacteriology it is used as an effective means of excluding dust and germs from flasks in which experiments are to be carried on. In order to put various textures to an exact comparative test, an experiment was tried. Having selected six quart bottles with wide mouths, I tied over the mouth of each a piece of the filtering tissue which I wished to test. The bottles are not liable to crack, as wooden boxes are; the only access for the interchange of air in the interior was through the filtering texture. I thus had a means of testing the comparative value as strainers of the various materials. Within the bottles were placed glass slides on which any dust that was carried in might settle. The experiments were begun on May 5, 1891, and the slides were taken out

on January 6, 1892, and most carefully photographed by Mr. Lafayette, and made into lantern slides.

The bottles were placed near a window in a room in the building of the Leeds Philosophical Society, i. e., quite in the center of Leeds. The materials tested were: canvas; bunting; ordinary flannel; domette flannel, rough side in; domette flannel, rough side out; cotton-wool, one inch thick.

The results of the experiments show that as a consequence of eight months' exposure, including a week of the worst fog I ever knew in Leeds, three of the filtering tissues admitted a very appreciable amount of dust, viz., coarse canvas the most, bunting coming second, ordinary flannel admitting less than either. The other three bottles were screened, one with thick domette rough side in, one with domette rough side out, and one with cotton-wool about an inch in thickness. The last three show hardly a trace of dust. Curiously, the cotton-wool shows a trace more than the domette flannel. The explanation of this I suspect to be that the cotton-wool was not tied firmly enough round the neck of the bottle, which had no rim, and that some air passed between the bottle and the wool, instead of through the wool.

Another experiment which I tried was to fit up a cupboard with panels of double domette flannel. After the fog, to my surprise, the inner screen had become more or less black, showing that black particles had passed into the cupboard, but with this remarkable difference: whereas the outer flannel was almost uniformly black from top to bottom, the inner flannel was divided into four squares of different shades of blackness, corresponding to four spaces between shelves. Of these four, the lowermost was almost as black as the outside, and the uppermost was almost clean. I just mention this as a fact which needs an explanation, but without suggesting one.

There is one error which I think has been committed in the screens made for me, and it was pointed out by my friend Mr. White, the architect, of Wimpole Street. The filtering material is likely to act more effectively if left loose and not stretched tight, as when tense the interstices are stretched and made larger, and when out of sight it might be very loose, almost baggy, with advantage.

Hoping to get some hints as to the comparative value of the various textures under trial, I placed specimens of each under the microscope. It is obvious that both canvas and bunting are of too open a texture, having numerous small holes unguarded by delicate fibers. Judging by the microscope, one would conclude that of woven textures, probably flannel, and still more, domette flannel, are the best, and this judgment seems to be borne out by the experiments with the bottles.

This is a question which experience alone can decide. Doubtless the larger the area of screened opening, the more effective the filtration. For a book-case with glazed front, probably the whole of the back might be made of flannel loosely fixed over the necessary skeleton framework. For a cupboard or closet, every panel should be replaced by a screen. If the closet have a window, all crevices and joints in the window should be pasted up to exclude the soot, otherwise the wind from the outside, or the fires of the house from the inside, will force the air soot through. On the other hand, it is probably true that, given very perfect fitting and workmanship, aided by the interposition of velvet, as hereafter described, where the edges of the doors come in contact with their frame, a much smaller area of filter, perhaps even a simple tube, filled with cotton-wool, may prove to be efficient. These, however, are points on which further experience is needed, and which may, ere long, be settled by experiment.

Where shall we place our screen? This is a question which admits of a variety of answers, and gives scope for endless ingenuity. In anything which is being newly made, such as the cupboards and closets of a new house, or in new furniture, we are masters of the situation. In many of them we may substitute at the back our filtering texture for wooden boards, and perhaps even save expense thereby. In closets we may replace the panels of the door by filtering texture, guarding the closets, if necessary, against thieves by wire netting or iron bars fixed on the inner side. As a rule, chests of drawers may have the filter over the whole surface at the back, care being taken that the back of each drawer falls half an inch short of the top of the drawer, to allow free entrance of air from the screen. In one set of drawers, so placed that I could not get at the back, the difficulty was got over in this way: In the front of each drawer a series of twenty holes, of an inch diameter, was made for admission of air. The filter, on a frame, was fixed on the inner surface of the front of the drawer, so that the material should stand half an inch away from the holes. A somewhat similar plan was adopted in a bureau. About twenty large holes, two inches in diameter, were cut in the wood-work at the back, some of the holes being opposite pigeon-holes. Then the whole was covered with bunting, on a frame so arranged that the bunting was fully half or two thirds of an inch away from the wood. Another method has been adopted at the Yorkshire College for some of the cases. The filter was applied at the roof, somewhat after the fashion of a weaving-shed roof, the vertical face being filled in by the screen. Again, Mr. Branson has provided a roof filter for a case of scientific instruments, by placing the screen in the roof of the case, and protecting it by a false roof two inches above it, to prevent its being choked by falling dust.

What shall we do with crevices and cracks? At first, I hoped that narrow chinks might be ignored, on the principle that easy passages of air through an ample screen would virtually stop off currents through narrow spaces. In this I have been disappointed, as, in some cases, a chink, though apparently narrow, has proved too accommodating to the passage of air, and a more ready channel than the interstices of flannel. My rule now would be to close or guard with filtering material every place where the door comes into contact with its frame.

The plan I have adopted with the doors of several cupboards and closets is this—to put strips of cotton velvet wherever the door comes into contact with its framework. On the side where the hinges are, the velvet is glued and sprigged to the edge of the door; on the other side and the top the velvet is fixed to the rebate against which the door presses. If the door belong to a closet, and the bottom is not in close contact with the floor, a small piece of flannel or cloth may be fixed along the inner side of the bottom of the door, so as to form a curtain which closes the gap, and filters any air that passes through.

Such, then, are the principles which may guide us to a victory over dust, and such are some of the details whereby we may work out a method by which the victory is to be won. Do not suppose that I claim to have completely conquered the enemy; but a beginning has been made, a beginning definite enough and assured enough to encourage others, and especially architects, to study the question and to make trials. If they will but work with determination to conquer, they may confer upon the community a most welcome amelioration of some of the smaller miseries we have to submit to.

And now let me venture to tell you what I should do were I to construct an office in the center of a town. I should begin with the fireplace. Let it be constructed on the principles I have been teaching for the last ten years, and which were brought to a focus in my lecture at the Royal Institution in 1866—principles which are at last influencing the construction of fire-grates throughout the kingdom. Shortly stated, they are:

1. The back and sides of the fireplace to be fire-brick, built solid.

2. The depth of grate from front to back never to be less than nine inches.

3. The back to lean over the fire, not to lean away from it.

4. The front bars to be vertical and thin, not horizontal and thick.

5. The ash-place under the grid to be made into a closed hot chamber by a movable shield, named an "economizer."

The effects of this construction are:

(*a*) Great diminution of dust, since the ashes fall into a closed ash-chamber.

(*b*) Better warming of the room, with a diminution of about one fourth in the quantity of coal used.

(*c*) Diminished draft across the floor, from diminished roar up the chimney when the fire is burning briskly.

(*d*) Diminished production of soot.

These are the principles which I have urged, and they are open to every one to adopt. I do not speak of a further improvement, as it is the subject of a patent, and is not open to every one to copy.

Having made sure of my fire, the next step would be to secure admission of air to supply the fire, without making a draft or introducing dirt. As far as I know this is best done by the "Harding diffuser," which admits air directly from the outside and delivers it through a series of small jets near the ceiling. To shut out the smuts the air passes through a canvas screen placed diagonally in a flat tube, which leads up to the "diffuser" and gives a filtering area about six times the sectional area of the tube. This air is admitted into the room by a legitimate channel, and is filtered. The "Harding diffuser" was once patented, but the patent has lapsed.

Having thus secured a supply of air for the chimney, we can afford to deal with the windows, and make them air-tight, without fear of the chimney smoking. Now I should like to see a revolution in windows, at any rate, wherever we can be content with panes of moderate size, and can have the heart to surrender plate glass.

Three things are required of a good window:

1. That the outside of the window may be cleaned by a servant standing inside the room, whereby the risk and expense of cleaning from without are avoided.

2. That it shall exclude wind and dirt, even under the stress of a gale.

3. That the air of the room, especially in frosty weather, shall not be itself so chilled by contact with the large surface of glass as to cause induced cold currents, which have not even the merit of being air freshly introduced.

To attain these points, the sash window must be abandoned. The window must be so divided that one half vertically, or in a large window one third, may open inward on hinges, the other half or two thirds being fixed, and therefore wind-tight; the breadth of each division to be such that a servant's arm can reach out and clean the outer side of the fixed window as she stands inside the room. In the case of three divisions the fixed windows would be to the right and left of the hinged window. The hinged

window should be in two or three divisions, according to the height, not in one large casement from top to bottom. Thus have we provided for my first requirement, the cleaning of the window. The hinged window must be so constructed that when closed the framework of the window locks into a double rebated fast frame, after the manner of a jeweler's show-case. Then, if well made, it would fit tight and keep out wind and dust. This provides for my second requirement.

Lastly, the panes should be doubled—that is, a second pane must be placed inside the ordinary pane at a distance of about five eighths of an inch. The outer pane is fixed by putty in the usual way. The fixing of the inner pane is peculiar and all-important. The inside of the frame is cut to receive the glass exactly in the same manner as the outer side for the outer pane, but the inside pane must not be fixed by putty, but is held in place, "sprigged" firmly against its rim, "the rebate," by small nails, two in each side, very carefully put in. Why do I insist upon this mode of fixing the inner pane? For two reasons: one, to make it easy to remove the inner pane if ever it should be necessary to clean the inside of the two panes; the other reason is, to enable me to render cleaning of the inside unnecessary. How is this achieved? By facing the flange, against which the pane is pressed, with cotton velvet. The air that must perforce pass in and out of the space between the panes must pass the velvet, and be filtered. Two windows of my bedroom thus treated five years ago have never needed to be cleaned; and a pane, which was removed at the end of four years for inspection, was absolutely clean. Another advantage of the double panes is this: When my other windows with single panes are steamed all over, and even glazed by the frost, the outer panes of the double window show hardly a trace of unfrozen steam; the inner panes are never steamed. Again, a thermometer placed between the panes has never been below 30° all this severe weather, even though a thermometer outside the window has been several times below 20°.

Lastly, I would treat the cupboards and drawers after the manner already described. The result would be, not absolute freedom from dirt, nor absolute protection from London fog, but such a departure from what is commonly experienced as to make the experiment well worth all the trouble it costs.—*Journal of the Society of Arts.*

Of the three hundred and twenty-three asteroids known on February 1st, seventy were discovered by American astronomers—forty-eight by Peters and twenty-two by Watson. Peters stands second on the list of successful discoverers. Palissa, who is first on the list, is credited with the discovery of eighty asteroids.

THE COLORS OF WATER.

By CARL VOGT.

"GRANDPA," asked my two grandchildren, as if with one voice, "shall we pass over the blue lake when we go to Geneva?"

Our residence at Salvan, a charming village of the canton Wallis, about a thousand metres above the level of the sea, was nearing its end. The return journey was the subject of lively conversation, and we were almost entirely occupied with the fancies of the children, who asked no end of questions. "We shall go across the blue lake," I said. "First we shall go down to the station. Grandma and I will go in carriages, you others will walk. Then we shall take the railway train and go down to the lake. The steamboat will be there, and as soon as we are aboard—"

"Grandpa," interposed the others, "why is the lake so blue?"

I was somewhat confused by these questions. If a fool can ask more questions than ten men can answer, a child can perplex more than a hundred grandpas. An evasive reply, like "It is blue because it is not yellow like the Oder at home," was not available with my children. It is an old observation that the simpler a phenomenon of Nature appears at first sight, the more complicated it is in fact; but it is always well to recollect that there is no simple phenomenon in Nature, that all that ever happens or is perceived by our senses is only a result of very different or even opposing forces and causes, which we must not only learn by observation, but must also separate from one another by experiment, if we would come to a conclusion that has hands and feet. Every one can see that the Lake of Geneva is blue, and most persons regard the subject as quite simple and clear, without probing further into the causes of the blue color. But if a child in his *naïve* candor asks for the reason of this color which has struck him because the waters of his home are not like it, there floats before the mind of the expert an unanticipated multitude of problems in optics involving the most difficult laws and broad knowledge, and over which mathematicians and physicists and students of every kind, artists and poets, have racked their brains, without having ever reached a definite solution. How, then, shall he convey ideas to a child which shall give an answer to the question adapted to his powers of comprehension?

I was thinking of preparing a small water-color drawing, when

the children asked their eager question. Why should I not invoke the Muse to the help of art? A large cylindrical glass, holding a litre, stood on the table, filled with the superb water that gushes out of the slates fresh and cool, crystal clear, and chemically pure.

"Look at the water in the glass," said I; "of what color is it?"

"I don't see that it is of any color," said one. "It is red," said the other.

"But that comes from the flowers that are behind it," replied Annie. "Come round to where I am; it doesn't look red from here."

Lili ran round the table, and confessed, a little vexed, that the water was not red. She had a disposition, perhaps, like Lessing's, who was dissatisfied because the spring was always green, and not, by way of change, sometimes red.

"Is it not true, grandpa, that water has no color?"

"Yes, dear child, it is blue, but so little so that you can not see it."

"Can you see that it is blue?"

"No; but still it is blue. Look at this."

I took a little ultramarine on the end of the brush and mixed it with the water. "Does it look blue now?"

"No; I see nothing."

"Nor I. But you saw how I put a little blue color in it with the brush."

"Yes, but there was not enough of it. Put more in."

I silently took the glass and set it on a piece of white paper in the bright sunshine. "Now look from above down into it."

"It is blue!" said the little one, clapping her hands, "but only a very little."

"Look at it from the other side, where the sun is shining into it. Is it not a little bit red, like the bell-flowers which you picked yesterday?"

"That is wonderful," said the little one. "It is blue from above, a little bit red in the sun, and when we look at it from this side of the room we see nothing!"

"Think about it a little. The glass is as broad as my finger is long. But it is at least three times as high as my finger. When you look at it from the side, you see only a finger's length of water; but when you look down into it, you see through three fingers' length of water—three times as much. You see it blue from the side, and three times as blue from above, don't you?"

"Is that really true?" said the little one, as she measured with her finger. She nodded that she was satisfied.

"Now imagine that the water is as deep as the height of the

church-steeple, and deeper—that it reaches from here up into Salvan and down to Vernayaz. Then you would see the water from above it all blue."

"Is the lake, then, really so deep?"

"Yes, and deeper."

I will not continue the conversation any longer. It went on with various simple experiments, beginning with differently colored stones, which I let drop into the water, and then placed on the white, then with setting the glass with its weakly bluish contents on differently colored papers, and ended with my trying to make the children perceive how the colors changed when they were seen through the whole depth of the glass. I will not say that the little ones were brought to a full comprehension of the matter; but they stuck fast to the assertion that water is blue, of an infinitely weak blue, and that the blue color can not be seen till one looks into a certain depth of it.

Physicists first acquired this knowledge by means of an experiment of Bunsen's, who let a piece of white porcelain fall into a tube filled with distilled water, and satisfied himself that the descending piece looked bluer as it sank deeper. Bunsen had, of course, provided that only white light reflected from the ceiling of his room should fall into the tube, and not the blue light of the sky. The experiment has been modified in various ways, and made more convenient, but has always given the same result; and it is now established as a scientific truth that chemically pure water, free from all other constituents, either dissolved or floating, has a bright, clear, blue color.

But there is no such water in Nature, for rain-water, even distilled—water evaporated out of the sea and everywhere, and carried on in the form of clouds, and falling in drops—even that rain-water contains some dissolved substances, and still more of little microscopic bodies that are floating in the air which the drop carries with it in its fall.

Yet we can assure ourselves at least as to the dissolved salts, in which sea-water, for example, is rich, that they are all, particularly common salt, colorless in the crystalline condition, and therefore have not the least influence on the color of sea-water. Seamen and sailors, although uninstructed in this matter, and without knowledge, know very well that they, going away from the coast, in a short time reach the clear, the "blue water," and then sail over deeps till they can not reach the bottom with their anchors.

I have already said that every phenomenon in Nature is a complex affair, and depends on many causes and conditions. This is true of the coloring of large masses of water, as of lakes and seas, which are indeed, as is known, of very different shades. It

may be permitted to consider here a few of the conditions that have an influence on the general effect.

A still-water surface forms a mirror which reflects those colors of the horizon that fall upon it at the same angle as that under which the eye stands to it. When I am at the shore of a quiet sea, or of a still lake, the water beams with the colors of the horizon. In a bay surrounded by woods, I see a deep gray; on the broad surface at sunset, the liveliest yellows and reds; looking straight down from my boat, the blue of the sky over my head.

These reflected colors concern the physicist the least, for he knows that every reflecting surface returns them; but they interest the painter almost exclusively. They constitute the tone of his landscape; they enliven the otherwise monotonous, dead surface, and he as well as the looker at his picture receives chiefly the impression of them. They are for the most part the colors of the lower horizon, for the point of view of the spectator is usually only a few metres above the level of the water.

Thus with the smooth mirror. But the scene changes immediately upon the slightest agitation. It is very seldom that the sea is quite still. The waves form hills and valleys, their surfaces are more or less inclined, and they reflect not the horizon with its down-toned colors, but the more saturated tints of the zenith. Whoever has seen the Mediterranean Sea or the Lake of Geneva under a cloudless sunset, and a slight rippling of the waves, will recollect that the surfaces glowing with burning yellows and reds, are broken up by sharp, deep-blue lines; they are the wave-valleys, which, by reason of their oblique inclination, turn the blue colors of the zenith into the eye. But this is not all. With the smooth mirror surface, and lower point of view, the eye not only receives the rays reflected from the surface, but it pierces through the inclined parts of the wave-valleys into the mass of the water, and thus perceives the proper color of the water, more intensely as the small surface of the wave-valley stands more perpendicularly to the eye. If the waves are very short, and follow one another rapidly, this impression of the color of the water will overcome that of the reflection. I can satisfy myself of this fact at any time.

The windows on the western front of my house look toward the Arve, which is here crossed by a dam that causes a fall of about a metre. Above the dam, the glacier-stream, colored a grayish yellow in summer and green in winter, is perfectly smooth; and from my windows, which are situated about six metres above the river, I can see hardly any but the mirror colors, yet a little mingled with the proper color of water, which appears considerably stronger when the sky is covered and its glaring light does not—as the painters are accustomed to say—"eat up"

the softer tones. But below the dam the water is in lively motion with endless little racing wavelets, and here the green color comes out so vividly that the reflection almost wholly vanishes. Yet another fact is revealed by the movement. Only with a perfectly smooth mirror surface are the outlines of the reflected objects fully clear and sharp. The reflection is then so perfect that one often hardly knows whether he sees the objects themselves or only their mirrored images on the water; and the lines between water and shore are quite effaced. The slightest movement causes the outline of the mirror picture to appear notched; clearer lines from the horizon creep into the darker colors of the picture, but notches from these, too, spring out over the lines which the outline should have. This phenomenon is so common that we notch the borders of water reflections in colored pictures, as well as in those drawn only in black. I have no doubt that a relationship lies at the bottom of this phenomenon like the fact observed by Colladon, and now often remarked, that water in motion carries the light along with it. A stream of water, flowing through a dark tube out of an illuminated receiver, carries the light along, whether it be white or colored, and shines; why should not moving waves exhibit the same effect?

But enough of these painters' impressions, which, as we have said, are neglected by the physicist, but are still of the highest significance for the beholder as well as for the artist, and, as may result from our representation, are dependent on various factors, among which, besides mirroring, the real color of the water is to be considered.

Let us go a little closer into this matter.

Pure or colorless water containing salts in solution is beautifully blue and perfectly transparent, at least to a certain depth. It is, hence, clear that with the color of all objects visible at this depth, and constantly reflecting the rays of light, is associated under the water a blue tone, more intensive as the depth at which the object lies is greater. The gravels on the shore of a lake or the sea become, when seen through the blue water, as if they were observed through a pane of blue glass; and since all shore figures, with trifling exceptions, are of a yellowish color, they will shine of a more or less green color, and the water on the shore will likewise appear green.

I here lay aside all physical deductions concerning the nature of color. We know that it is not, as was once thought, a property of bodies, but that a transparent body like water, for example, shows a distinct color, because it lets certain colored rays through, but not others, and that a solid body reflects the rays which we perceive, but to a certain extent absorbs the others. The discussion of the nature of color is not of very great importance for our essay.

Blue water also takes on another tint when objects lying on the ground are seen through it, and this mixed color tone depends on the color of the ground. We can easily verify this by the simple experiments described above with blue colored water in a cylinder glass. White bodies, pieces of porcelain for instance, appear light-blue, yellow-green, red-violet, and, the deeper they sink, the more is this shading from blue washed out, till it is destroyed. The red shades vanish first of all.

The depth to which no trace of bottom-colors reaches us is certainly not little, and may, under favorable conditions, be estimated at several hundred metres. But the question is a large one, and we will consider a little more carefully to what extent the more or less favorable conditions I have mentioned have been determined.

I have already said that pure water does not exist in Nature. It always must contain dissolved or floating substances which will change its colors. Peat waters contain brown and blackish organic matters in solution. They may be perfectly clear and transparent, but the colors which the humus acids and similar substances lend them will always produce a certain effect upon them, which will be re-enforced by the dark-brown or black colors of the bottom of the peat lakes. It has also been observed that filtered water from a blue lake on evaporation leaves a white or light gray, and that from green lakes a yellow sediment; and that thus blue lakes contain white matters and green lakes yellow ones in solution, whose colors produce with those of the water mixed tints. The difference in the colors of the Lake of Geneva and of the Bodensee is explained on this principle, but the results of the experiments on which the conclusion rests have been disputed, and there is much room for doubt on the subject. Whatever may be thought of this, it is certain that no water in Nature is perfectly clear and transparent, but is more or less turbid by the presence of other substances floating in it. That this turbidity is of greater or less importance, that we can distinguish at greater or less depths objects swimming in the water, like fishes, or lying on the bottom, are taught by daily experience as well as by experiments which have been made by sinking solid bodies in sunlight and on cloudy days and at different seasons, or by letting down sources of light, such as burning lamps and incandescent electric lights, and ascertaining the depth at which a perceptible glimpse of them can be obtained. It is to be regretted that these as well as other experiments upon the penetrating power of light have been made only in waters not quite clear, as in a few Swiss lakes and the Mediterranean Sea. Whoever has traveled on the coasts of Norway must have been astonished at the transparency of the water in many of the fiords; it is also affirmed that in some

of the North American lakes the eye can perceive objects on the bottom at the depth of several hundred metres. Visibility extends to no such depths in either the Lake of Geneva or the Mediterranean Sea. The water of the Lake of Geneva is more transparent in winter than in summer, but in this lake, as well as in the sea-waters that have been thus far examined, the extreme limits of visibility are at forty-five, and at most fifty metres' depth. Observations in diving apparatus have shown that one is there as in a blue cloud, and can only see some seven or eight metres in a horizontal direction, in exceptional cases twenty metres, and at most twenty-five metres. But the seeing man can dive with the apparatus only to a depth of thirty metres, and, although he can not see clearly, he is surrounded by diffuse light.

The light from above must therefore penetrate more deeply. A more closely approximate measurement has been made by such means as sinking sensitized photographic plates into the water, and exposing them to the light at fixed depths, or by sinking substances which are chemically acted upon, changed, or destroyed by light, so that the measure of the alteration may at the same time furnish the measure of the strength of the acting light. Photographic experiments have shown that a depth of four hundred metres in the Mediterranean Sea is the average limit to which a blackening of the plate can be verified.

Thus light penetrates to ten times as great a depth as our eye, and this is an important point—a whole zone, three hundred metres in thickness, receives light and thus also sends up rays which our eyes can not immediately distinguish, but in all probability perceives through the mixture of the color tones which they produce. It is known that there are other differences than those of blindness to certain colors in the eyes of men, and that our organs may be trained to an extraordinary degree of delicacy in the observation of the finer tints. I once visited the Gobelins tapestry factory in Paris in company with some painters; the workmen could distinguish with ease and indubitably tints which looked identical to our unskilled eyes. There must, to return to our subject, radiate up from that depth to the surface, light, of a bluish color, which makes far less impression on our eyes than the colors called warm, yellow and red, which—especially the latter—are absorbed by the water.

It was formerly believed that total darkness reigned in the greater depths of a thousand metres and more, and that the collected colors of deep water were seen on a black ground. But, in the light of the recent deep-sea investigations, this idea must be given up, along with the other one that once prevailed, that there is no animal life in great depths. Most animals living in dark caves have atrophied or no eyes; there are also living

beings found on the surface of the earth, which hide themselves in dark places, under the ground, etc., and are blind. Similar conditions prevail in the great deeps. There are blind crustaceans there, which probably live in the mud and under stones, while others, moving animals, fishes, have large, well-formed eyes. It must be that they see, or in other words that there is light there. Whether this light is produced in the depth by means of the phosphorescent organs which many of these animals, even fishes, possess, or whether it penetrates from above, as might perhaps be concluded from the fact that some of the deep-sea animals whose organization compels them to creep on the ground have yellow and red colors on their backs, is of no importance so far as our inquiry is concerned. We can only reach the inevitable conclusion that we see the colors of water not on a dark or black ground but on one that is illuminated, if but faintly. This is of moment because, in the light of it, particles floating in water are illuminated not from above only, but from below too.

We can satisfy ourselves of the effects of the coarser floating matter of sand and mud, as well as of the fact that the color of masses of water depends to a large extent upon the color of such matter. The Arve, which flows in front of my windows, is grayish yellow in summer, and opaque, assuming a deeper color after rain-storms; in winter, on the contrary, it is green, semi-transparent, and greener and clearer the less water it carries; facts easily explainable upon principles which one of my pupils nearly established by observations continued through a whole year. In summer the Arve carries, with the surplus glacier-water, grayish-yellow fragments of the mountain rocks in great multitudes; after heavy rains, masses of yellow mud are added to these, having been washed away from the banks of the stream. In winter the amount of sediment derived from the glaciers is small, and the blue color of the water is transformed into the green mixed color. Every glacial stream has its individual color, derived from the disintegrated rocks; and it is not without reason that the two rivers which join at Zweilütschine, in the Bernese Oberland, are known as the Black and the White Lütschine. The one brings disintegrated white limestone, the other the emery of pulverized dark slates.

How extraordinarily strong the mixed colors produced by sedimentary matter may appear was shown me by an observation which I made at Nice at the end of December, 1889. The weather had been fine for a few days, and the sea, which I overlooked from my window to Cape Antibes, about fifteen kilometres away, had been unusually blue. Now came stormy weather, with sporadic showers in the mountains of the Var. The river, whose mouth is about six kilometres from my house, poured considerable

masses of saturated ochre-colored water into the sea, and there was a sharp boundary of waves between the clay-yellow tongue which continually licked itself farther into the sea, and the deep-blue salt water. After a few hours the yellow tongue became bordered with a widening green band, so brightly, so poisonously green, that I was induced to apply my whole stock of green (vert Paul Veronese) to the completion of a study on which I tried to fix the phenomenon as truly as possible. Under the blowing of the west wind the tongue stretched itself out farther, to the rocky shore behind the harbor of Nice, around toward the bay of Villafranca; and when I visited the latter place the next day the water appeared, not steel-blue as usual, but green, fully green; and the fishermen of the zoölogical station there complained that no marine animals could be found swimming around, because they had fled from the green water. The blue color returned after a few days. The green was produced by the finer yellow floating matter; the coarser particles had already sunk.

The finer matter keeps afloat for a very long time. G. Bischof put some of the flood waters of the Rhine in large casks, and deposited these in the cellar of the chemical laboratory at Bonn. The finer particles had not yet entirely settled, and the water had not become clear, after several months of absolute stillness. It is plain that in a lake, in which the continual inflow and outflow keep up a constant current, though it be slight and unremarked by ordinary observers, fishermen and rowers, these fine floating particles will never come to rest, and that, since they have a yellow color, this will appear more intense in the deeper parts, because a larger number of yellow particles are floating in the thicker layers of water there. But, farther away, the shades which the floating matters of single brooks and rivers exhibit vary endlessly between gray, yellow, and reddish, and there result the most diversified and delicately shaded mixed colors, with constant variations according to the quantity of floating matter that is carried into the water-basin. Also in the sea, which is never quiet, the fine floating matter keeps afloat for a long time, and is distributed over immensely large surfaces.

Organic matters, plants and animals, have effects similar to those of mineral substances. The shores are covered with numerous plants; they grow on the lakes in all stages of green and brown (many microscopic plants, which cover the rocks as with a slime, are yellow or brown); green plants grow on the sea-shores to a depth of thirty metres, yellow and red sea-weeds to a still greater depth, forming semblances of woods and meadows, and mingling their colors with those of the water. Even in northern seas there are numerous stationary animals, sponges, solens, mussels, masses of which develop a definite color; while visitors

to southern seas are unable to say enough of the splendid colors conjured up by the coral reefs.

But even this is not all. All lakes and seas swarm with swimming or "pelagic" plants and animals. Green and yellow, one-celled, microscopic algæ are exceedingly common to a considerable depth; and green and yellow algæ sometimes come to the front in such masses that "the Red Sea" becomes no arbitrary designation, but the correct expression of an observed fact. I have seen the bay of Villafranca colored partly red by millions of swimming *Anchinia rubra* about as large as peas; I have seen mile-long strips, several metres broad, immediately along the shore on the Riviera, colored a deep royal blue by compressed masses of swimming salleemans (*Velella spirans*).

We can not absolve the transparent swimming water-organisms, from the larger medusa down to the infinitesimal microbes, from having a certain amount of influence on the color of water. We should not be able to see their crystal-clear bodies if they did not refract the rays of light in a different direction from the surrounding water. By this means they send out a multitude of refracted rays, which singly are of little importance, but in the aggregate must produce an effect through their accumulation when millions of these living beings are crowded into a cubic millimetre. To what purpose should we have in some parts of the retina of our eye a million of sensitive elements or rods to the square millimetre, if we could not seize single impressions and unite them into a view of the whole?

Finally, we will not forget the air that is mixed with the water. If we shake a viscous fluid in the air, it becomes whitish, and at last white, like milk. Yet the fluid and the air are both transparent. But the air-bubbles scattered through the water refract the light in another way. The wave looks whitish, quite white on its edges, from the inclosed air, and as the motion grows stronger the white becomes more prominent, with a greenish tone when the water is clear and the sky clouded, radiant yellow in sunshine, and clay-yellow when the water is not clear. All these tones mix with the colors of the deep, and with the mirror-colors of the surface. Thus the question of the causes of the colors of water rises to be one of the most complex problems of science as well as of art, the full solution of which has not yet been reached, in spite of the various efforts of men of science and of pictorial artists, because in order to meet the apprehension of the common eye they have to continue into a picture the endlessly changing colors and shapeless figures which the sea affords. But when I stand before a wave painted by Mazure in Paris (he is there usually called *Mazure le Vague*, the Wave-Mazure), and see how that artist, without help of shore, walls, buildings, or ships, which sup-

port the eye by their forms, shows me a wave from the sea with its reflected and refracted colors harmoniously mingled with the bottom tints issuing from the deep and with the proper color of the water itself, my arms, as they say, fall from my body. And it is then hard for me to realize that the colors of water in general are composed of a multitude of factors, among which the most important are the normal blue of pure water, the mirror-colors of the surface, the refracted colors of the moving parts, the proper colors of bodies swimming in the water, and the colors of the bottom or of only very softly illuminated parts shining up through the mass.

In this, as in everything, the principle is true that there are no simple phenomena in Nature, but that all are only the result of a number of single factors, the aggregate effect of which we observe and perceive with a very imperfect instrument—our eye. —*Translated for The Popular Science Monthly from Die Gartenlaube.*

THE ANIMAL VIEW OF MAN.

ONE of the most curious and unconsciously paradoxical claims ever advanced for man in his relation to animals, is that by which M. Georges Leroy, philosopher, encyclopedist, and *lieutenant des chasses* of the Park of Versailles, the vindicator of Buffon and Montesquieu against the criticisms of Voltaire, explains in his Lettres sur les Animaux the intellectual debt which the carnivorous animals owe to human persecution. He pictures with wonderful cleverness the development of their powers of forethought, memory, and reasoning which the interference of man, the enemy and "rival," forces upon them, and the consequent intellectual advance which distinguishes the *loup jeune et ignorant* from the *loup adulte et instruit.* The philosophic *lieutenant des chasses* had before long ample opportunities for comparing the "affinities" which he had discovered between civilized man and "instructed" wolves, in the experiences of the French Revolution; but without following his fortunes in those troublous times for game-preservers, we may perhaps return to the question of the natural relation of animals to man, which, as pictured by Rousseau to prove his *a priori* notions of a state of nature, so justly incurred the criticism of the practical observer and practiced writer, M. Georges Leroy.

That man is, generally speaking, from the animal's point of view, an object of fear, hostility, or rapine, is to-day most unfortunately true. But whether this is their natural relation, and not one induced, and capable perhaps of change, is by no means cer-

tain. Savage man, who has generally been first in contact with animals, is usually a hunter, and therefore an object of dislike to the other hunting animals, and of dread to the hunted. But civilized man, with his supply of bread and beef, is not necessarily a hunter; and it is just conceivable that he might be content to leave the animals in a newly discovered country unmolested, and condescend, when not better employed, to watch their attitude toward himself. The impossible island in The Swiss Family Robinson, in which half the animals of two hemispheres were collected, would be an ideal place for such an experiment. But, unfortunately, uninhabited islands seldom contain more than a few species, and those generally birds, or sea-beasts; and in newly discovered game regions, savage man has generally been before us with his arrows, spears, and pitfalls. Some instances of the first contact of animals with man have, however, been preserved in the accounts of the early voyages collected by Hakluyt and others, though the hungry navigators were generally more intent on victualing their ships with the unsuspecting beasts and birds, or on noting those which would be useful commodities for "traffick," than in cultivating friendly relations with the animal inhabitants of the newly discovered islands. Thus, we read that near Newfoundland there are "islands of birds, of a sandy-red, but with the multitudes of birds upon them they look white. The birds sit there as thick as stones lie in a paved street. The greatest of the islands is about a mile in compass. The second is a little less. The third is a very little one, like a small rock. At the second of these islands there lay on the shore in the sunshine about thirty or forty sea-oxen or morses, which, when our boat came near them, presently made into the sea, and *swam after the boat.*" Curiosity, not fear or hostility, was, then, the emotion roused in the sea-oxen by the first sight of man. The birds, whales, and walruses in the Wargate Sea and near Jan Mayen's Land were no less tame, and the sea-lions in the Southern Pacific, the birds that Barents first disturbed in Novaya Zembla, and even the antelopes which the early explorers encountered in the least-inhabited parts of central South Africa, seem all to have regarded the newly discovered creature, man, with interest and without fear. Sir Samuel Baker, in his Wild Beasts and their Ways, remarks on the "curious and inexplicable fact that certain animals and birds exhibit a peculiar shyness of human beings, although they are only exposed to the same conditions as others which are more bold." He instances the wildness of the curlew and the golden plover, and contrasts it with the tameness of swallows and wagtails. The reason does not seem far to seek. The first are constantly sought for food, the latter are left undisturbed. Perhaps the best instance of such a contrast is that of the hawfinch

and the crossbill, birds of closely allied form and appearance. The hawfinch, which is probably the shyest of English small birds, seems to have acquired a deep mistrust of man. But the crossbills, on the rare occasions when they descend from the uninhabited forests of the North into our Scotch or English woods, are absolutely without fear or mistrust of human beings, whom they see very probably for the first time. When animals do show fear on first acquaintance, it is probably due, not to any spontaneous dread of man as man, but because they mistake him for something else. "Nearly all animals," says Sir Samuel Baker, "have some natural enemy which keeps them on the alert, and makes them suspicious of all strange objects and sounds that might denote the approach of danger": and it is to this that he attributes the timidity of many kinds of game in districts where they "have never been attacked by firearms." A most curious instance of this mistaken identity occurred lately when Kerguelen Island was visited by H. M. S. Volage and a party of naturalists and astronomers, to observe the transit of Venus. There were large colonies of penguins nesting on the island, which, though the place is so little frequented by man, used at first to run away up the slopes *inland* when the sailors appeared. They apparently took the men for seals, and thus took what appeared the natural way of escaping from their marine enemies. They soon found out their mistake, for it is said that "when they became accustomed to being chased by men"—an experience for which the sailors seem to have given them every opportunity—"the penguins acquired the habit of taking to the water at the first alarm." In another colony, the nesting females would settle down peacefully on their eggs if the visitors stood still. "The whole of this community of penguins (they numbered about two thousand) were subsequently boiled down into 'hare-soup' for the officers and men of H. M. S. Volage," writes the Rev. A. E. Eaton, "and very nice they found it." We may compare with this destruction of the penguins, the letter of Hakluyt on the voyage to Newfoundland by Antony Parkhurst, describing with high approval the business facilities for the fishing trade offered by the tameness of the great auks—called "penguins" in the passage: "There are sea-gulls, musses, ducks, and many other kinds of birdes store too long to write about, especially at one island named 'Penguin,' where we may drive them on a planke into our ship as many as shall lade her. These birds are also called penguins, and cannot flie; there is more meat in one of them than in a goose. The Frenchmen that fish neere the Grand Bank doe bring small store of flesh with them, but do victuall themselves alwayes with these birdes."

The point of view from which the lion or tiger looks on man

is perhaps not so far removed from that of the non-carnivorous creatures as might be supposed. Man is certainly not the natural food of any animal—except of sharks and alligators, if he is so rash as to go out of his native element into theirs—and if the item "man" were subtracted from the bill of fare of all the carnivora, they would never want a meal. The notion of the natural attitude of a lion to a young lady—

> "When as that tender virgin he did spye,
> Upon her he did run full greedily,
> To have at once devoured her tender corse,"

is still popular, but hardly correct. More probably the lion would get out of the way politely—if we may judge by the pacific behavior of those in our last-explored lion-haunt, Mashonaland. M. Georges Leroy's contention for the natural affinity, or semi-sympathy, which should exist between man and the intelligent hunting animals is no doubt partly reasonable. Leigh Hunt was unpleasantly struck by the *incongruity* of the notion of being eaten by a wild beast—"the hideous *impracticable fellow-creature*, looking one in the face, struggling with us, mingling his breath with ours, tearing away scalp or shoulder-blade." But the "fellow-creature" is not nearly so impracticable as he is supposed to be. More human beings are probably killed by tigers than by any other wild beast, except by starving wolves. Yet this is what Sir Samuel Baker has to say on the subject: "There is a great difference in the habits of tigers. Some exist upon the game in the jungles. Others prey especially upon the flocks belonging to the villagers. A *few* are designated 'man-eaters.' These are sometimes naturally ferocious, and having attacked a human being, *may* have devoured the body, and thus acquired a taste for human flesh; or they *may* have been wounded on more than one occasion, and have learned to regard man as a natural enemy. But more frequently the 'man-eater' is a very old tiger, or more probably tigress, that, having hunted in the neighborhood of villages and carried off some unfortunate woman, has *discovered* that it is far easier to kill a native than to hunt jungle game." As a rule, the tiger is only anxious to avoid men; and it is noticed that in high grass tigers are more dangerous than in forests, because in the former they can not be seen, neither can they see, until the stranger is close upon them. An ancient instance of the opposite behavior is that recorded of the new colonists of Samaria, whom the lions attacked, and "slew some of them." A curious inversion of this experience occurred when the islands in the Brahmaputra, which were swarming with tigers, were first cultivated. The natives, mainly by the aid of traps set with a bow and arrow, killed off the tigers so fast that the skins were sold by auction at

from eight annas to one rupee apiece. In this case, the tigers were the first aggressors by carrying off cattle. But it seems evident that there exists no *a priori* reason, founded in natural antipathy, why man and animals, if we could reconstruct a "state of nature" in which we could put civilized, not savage man, should not dwell together in profound peace, or at least in such peace as obtains between accidental neighbors. The only ground for quarrel that seems inevitable is the everlasting one between the shepherd and the wolf; and that, after all, is a question not of prejudice, but of property.—*The Spectator.*

SKETCH OF WILLIAM HUGGINS.

DOCTOR HUGGINS is one of the leaders in the modern methods of astronomical research, and his name is associated with a considerable proportion of the discoveries that have been made respecting the constitution of the sun, stars, and nebulæ, and with the results in general of the application of physical investigations and of spectroscopic observation in particular to the heavenly bodies.

WILLIAM HUGGINS was born in London, February 7, 1824. He received his early education in the City of London School, and continued his studies in mathematics, the classics, and modern languages under private tutors. He devoted much time to experiments in natural philosophy, and by the aid of the apparatus which he collected he gained practical knowledge of the elements of the chief branches of physical science, including chemistry, electricity, and magnetism. He also studied, using the microscope, animal and vegetable physiology, and became in 1852 a member of the Microscopic Society. He developed a particular interest in astronomy, and, "under great difficulties," says one of the earlier biographies in Men of the Time, while still residing in the metropolis with his parents, "observed the planets and some of the double stars between the chimneys of London." The erection of an observatory in 1855, at his residence at Upper Tulse Hill, which he supplied with good instruments, gave him better opportunities for observation; and in 1858 he had an Alvan Clark telescope of eight inches aperture, mounted equatorially. He occupied himself here for some time with observation of double stars, and with careful drawings of the planets Mars, Jupiter, and Saturn. In the light of the knowledge gained in his physical studies he was not satisfied to follow in the beaten track of observation, but sought to broaden the field of study, and inquire as far as possible into the physical qualities of the sun and stars. A

means of conducting investigations of this kind, which his predecessors had not possessed, was offered in the method of spectrum analysis discovered by Kirchhoff; and he was first able to undertake the application of this method in the beginning of 1862. In preparation for the research he mapped the spectra of twenty-six of the chemical elements, publishing the results of his labors in the Philosophical Transactions of the Royal Society. In conjunction with Dr. William Allen Miller, he compared the spectra of some fifty stars with those of several terrestrial elements, and found that the stars are hot bodies, similarly constituted with our sun, and containing many of the substances found on the earth. In 1864 he and Prof. Miller reported to the Royal Society the results of their observations of the spectra of the planets Venus, Mars, Jupiter, and Saturn; but they had found the light from Uranus too faint to be satisfactorily examined with the spectroscope.

The study of Uranus was resumed with an improved telescope in 1871 by Mr. Huggins, and he found its spectrum to be continuous so far as the feebleness of its light permitted it to be traced, or from C to near G. A photograph of the spectrum of Sirius was obtained by Mr. Huggins and Prof. Miller in 1863, when observations were suspended. They were resumed by Mr. Huggins in 1876, with apparatus so arranged that the spectrum of the sun could be taken on the same plate, and this method was applied to other bright stars. After recording in his communication to the Royal Society his expectation, with apparatus then under construction, of obtaining finer lines which might be present in the stellar light than those that had been seen, and of extending the photographic method to stars that were less bright, Prof. Huggins referred in general terms to "the many important questions in connection with which photographic observations of stars may be of value." Another paper recording the progress of these investigations to the end of 1879 named thirteen bright stars, Venus, Mars, and Jupiter, and different small areas of the moon, to which the method had been applied. Six of the spectra belonged to stars of the white class, while Arcturus seemed to present a spectrum "on the other side of that of the sun in the order of changes from the white-star group." The photographs of the planets showed no sensible planetary modification of the violet and ultra-violet parts of the spectrum. The results of the photographs of lunar areas taken under different conditions of illumination were negative as to any absorptive action of a lunar atmosphere. The author was then preparing to attempt to obtain by photography any lines which might exist in the violet and ultra-violet spectra of the gaseous nebulæ. He further pointed out "the suitability of the photographic method of stellar spec-

troscopy, first inaugurated by his researches, to some other investigations, such as differences which may present themselves in the photographic region in the case of the variable stars, the difference of relative motion of two stars in the line of sight, the sun's rotation from photographic spectra of opposite limbs, and the spectra of the different parts of a sun-spot." The British Association address of 1891 includes a fine summary of the results to date of observations of this character as they bear upon the evolutional order in which in this paper he arranged the stars from their photographic spectra. Substantially the same order had been proposed by Vogel in his classification of the stars in 1874.

Dr. Huggins presented a paper on his examination of the great nebula in Orion in 1868, and referred in it to earlier observations. The discussion was continued in 1872, and in 1882, when the author threw out the suggestion of a hope that the further knowledge of the spectra of the nebulæ afforded us by photography might lead, by the help of terrestrial experiments, to more definite knowledge as to the state of things existing in those bodies. In communications to the French Academy of Sciences and to the Royal Society in 1889 he considered it probable that nebulæ yielding a spectrum of luminous rays, with a very faint continuous spectrum, which is probably formed in part by luminous rays in close proximity, are at or near the beginning of the cycle of their celestial evolution. "They consist probably of gas at a high temperature and very tenuous, where chemical dissociation exists, and the constituents of the mass, doubtless, are arranged in the order of vapor density. As to the conditions which may have been anterior to this state of things the spectroscope is silent. We are free, so far as the spectroscope can inform us, to adopt the hypothesis which other considerations make most probable. On Dr. Croll's form of the impact theory of stellar evolution, which begins by assuming the existence of stellar masses in motion, and considers all subsequent evolutional stages to be due to the energy of this motion converted into heat by the collision of two such bodies, these nebulæ would represent the second stage in which these existing solid bodies had been converted into a gas of very high temperature. They would take the same place, if we assume, with Sir William Thomson, the coming together of two or more cool, solid masses by the velocity due to their mutual gravitation alone. I pointed out in 1864 that the gaseous nature of these bodies would afford an explanation of the appearance of flat disks without condensation which many of them present. . . . In other gaseous nebulæ strong condensations are seen, and a stronger 'continuous' spectrum. The stage of evolution which the nebula in Andromeda represents is no longer a matter of hypothesis. The splendid photograph recently taken by Mr.

Roberts of this nebula shows a planetary system at a somewhat advanced stage of evolution; already several planets have been thrown off, and the central gaseous mass has condensed to a moderate size as compared with the dimensions it must have possessed before any planets had been formed." In 1891, after more definitely describing the appearance of Mr. Roberts's photograph, he said that "to liken this object more directly to any particular stage in the formation of the solar system would be 'to compare great things with small,' and might be indeed to introduce a false analogy; but, on the other hand, we should err through an excess of caution if we did not accept the remarkable features brought to light by this photograph as a presumptive indication of a progress of events in cosmical history following broadly upon the lines of Laplace's theory."

Dr. Huggins's spectrum observations on comets, in connection with those of other observers, satisfied him of the existence of different types, and that the same comet might present on one occasion one spectrum and on another the other spectrum; that they shine partly by reflected solar light and partly by their own light, the spectrum of which indicates the presence in the comet of carbon, possibly in combination with hydrogen. In the case of the Wells comet of 1882, he remarked that as Prof. A. Herschel and Dr. Von Konkoly had showed long before that the spectra of the periodic meteors are different for different swarms, it was not surprising that we now had a comet the matter of the nucleus of which under the sun's heat showed an essential chemical difference from the long series of hydrocarbon comets which had appeared since 1864. The spectrum of Coggia's comet (1874) indicated an approach to the earth of forty-six miles per second, while the real velocity of approach was only twenty-four miles per second. It was uncertain whether the whole or part of the difference in the velocity was due to the motion of the matter within the comet. It seemed probable, therefore, that the nucleus was solid, heated by the sun, and throwing out matter which formed the coma and tail; and part of this was in a gaseous form, giving the spectra of bright lines. The other portion existed probably in small incandescent particles; the polariscope showing that certainly not more than one fifth of the whole light was reflected solar light. In a paper on Photographing the Solar Corona without an Eclipse, Prof. Huggins spoke, in 1882, of problems of the highest interest in the physics of our sun connected with the varying forms of the coronal light which seemed to admit of solution only on the condition of its being possible to study the corona continuously, and to confront its changes with other visible phenomena presented by the sun. The spectroscopic method of viewing the prominences failed; experiments in

looking at the corona through screens of colored glass or other absorptive media had not been satisfactory. The author had therefore undertaken to use photography, and had satisfied himself that under certain conditions of exposure and development, a photographic plate could be made to record minute differences of illumination existing in different parts of a bright object, which was so subtle as to be at the very limit of the power of recognition of a trained eye, and even, perhaps, of those that surpassed that limit. Describing his apparatus and method, he showed that it was possible, by isolating through properly chosen absorbing media, the light of the sun in the violet part of the spectrum, to obtain photographs of the sun surrounded by an appearance distinctly coronal in its nature. He afterward found that, by using plates sensitive to violet light only, it was possible to do away with absorbing media and remove the difficulties that occurred in sifting the light. In 1886 Dr. Huggins accounted for his failure to obtain in England, since the summer of 1883, photographs showing satisfactory indications of the corona, by the existence in the atmosphere since the autumn of 1883 of finely divided matter which caused an abnormally large amount of glare. Mr. Ray Woods had met the same trouble in Switzerland in the summer of 1884.

In his British Association address, 1891, Prof. Huggins repeated a conclusion which he had expressed in 1885, that the corona is essentially a phenomenon similar in the cause of its formation to the tails of comets—consisting for the most part of matter going from the sun under the action of a force, possibly electrical, which varies as the surface, and can therefore in the case of highly attenuated matter easily master the force of gravity even near the sun—as according with the lines along which thought had been directed by the results of subsequent eclipses.

In the early part of 1868 Prof. Huggins presented to the Royal Society some observations on a small change of refrangibility which he had remarked in a line in the spectrum of Sirius as compared with a line of hydrogen, from which it appeared that the star was moving from the earth with a velocity of about twenty-five miles a second, if the probable advance of the sun in space were taken into account. The thought of discovering motion in this way was not wholly new, though Prof. Huggins was the first to apply it in practice. The Rev. John Mitchell, of the Royal Society, presented an ingenious paper, in 1783, On the Means of discovering the Distance, Magnitude, etc., of the Fixed Stars, in Consequence of the Diminution of the Velocity of their Light, in which he suggested that by the aid of a prism "we might be able to discover diminutions in the velocity of light as perhaps a hun-

dredth, a two-hundredth, a five-hundredth, or even a thousandth part of the whole." Doppler had also, in 1841, suggested that on the same principle on which a sound should become sharper or flatter if there were an approach or a recession between the ear and the source of the sound would apply equally to light; and Fizeau, about eight years later, had pointed out the importance of considering the individual wave-lengths of which white light is composed. Prof. Huggins was not able to continue his observations of this feature till 1872, when, having devised a trustworthy apparatus, and enjoying favorable weather, he applied his method to fourteen stars which were found to have a motion of approach and twelve which appeared to be receding. He remarked upon these results that the velocities of recession or approach assigned to the several stars by him represented the whole of the motion in the line of sight existing between them and the sun. As we know that the sun is moving in space, a part of these observed velocities must be due to the solar motion. He had not attempted to make this correction, because, although the direction of the sun's motion seemed to be satisfactorily ascertained, the velocity with which it was advancing rested on suppositions more or less arbitrary. It would be observed that, speaking generally, the stars which the spectroscope showed to be moving from the earth were situated in a part of the heavens opposite to Hercules, toward which the sun was advancing; while the stars in the neighborhood of that region showed a motion of approach. There were some exceptions to this general statement; and there were some other considerations which appeared to show that the sun's motion in space is not the only, or even in all cases the chief, cause of the observed proper motions of the stars. There could be little doubt that in the observed stellar movements we have to do with two other independent motions, namely, a movement common to certain groups of stars, and a motion peculiar to each star.

Pertaining to other subjects than spectroscopic astronomy on which Prof. Huggins has written, we notice a communication to the Royal Society On the Function of the Sound-post, and on the Proportional Thickness of the Strings of the Violin. A curious letter from him in Nature, in 1873, relates the case of a family of dogs the members of which had inherited an antipathy to butchers' shops and butchers. Some of them could not be induced to pass by a butcher's shop; others showed great uneasiness in the presence of a butcher, although they could not see him; and one of them attacked a gentleman visiting his master, whose business was that of a butcher. In 1872 Dr. Huggins edited and annotated an edition of Schellen's Spectrum Analysis in its Application to Terrestrial Substances and the

Physical Constitution of the Heavenly Bodies, translated by Jane and Caroline Lassell.

Dr. Huggins was elected a Fellow of the Royal Society in 1865, and has received two of its medals; he was awarded, with Dr. Miller, the gold medal of the Royal Astronomical Society in 1867, for their conjoint researches, and he was given a second medal of the same society in 1885. He has received doctor's degrees from the Universities of Cambridge, Oxford, Edinburgh, and Trinity College, Dublin; and he holds the honors and memberships of other British societies, and of numerous societies in foreign lands. As Rede lecturer at the University of Edinburgh, in 1869, he gave an account of his researches in astronomy by means of the spectroscope; and as President of the British Association in 1891 he delivered an inaugural address, the more definite purpose of which, as defined by the author, was "not to attempt a survey of the progress of spectroscopic astronomy from its birth at Heidelberg in 1859, but to point out what we do know at present, as distinguished from what we do not know, of a few only of its more important problems." The success of this effort, the Observatory says, was recognized equally by the general public and by those more familiar with astronomy. "Those who were already familiar with Dr. Huggins and his work have learned afresh almost to their surprise how closely he has been identified with the 'very remarkable discoveries in our knowledge of the heavens which have taken place during this period of thirty years.' Not that the president materially assists in pointing this moral; rather is it pointed by the facts in spite of him. He is almost too eager to assign credit to others when he might justly have mentioned his own work."

THE manufacture of flints is still carried on at the hamlet of Porcharioux, department of Loir-et-Cher, France, where the stone is abundant and of fine quality. The stones are quarried and roughly broken by the men, and are taken by the women into the house to be finished. A single worker can dress five or six thousand stones in a week. The use to which the flints are applied is not known to M. Belot, who has described the manufacture; but the business seems to be profitable. The work is attended with danger of lung disorders caused by the dust, a liability which the workers accept philosophically. The business is in the hands of a single family.

A RECENT investigation by Mr. Thomas Whitelegge, of Sydney, may cast some light as to the causes which influence marine food supplies. He found that a sudden discoloration of the water in Port Jackson Harbor was caused by the presence of a minute organism which he identified as a species of the genus *Glenodinium;* and, so far as he was able to judge, fully half of the shore fauna was destroyed by the invaders. The bivalves were almost exterminated wherever the organism was abundant during the whole of the visitation.

EDITOR'S TABLE.

THE "AMERICAN EXPERIMENT" IN EDUCATION.

STATE Superintendent of Education Andrew S. Draper lately delivered an address on education before certain teachers' associations. He also lately made a report on the same subject to the Legislature of New York. In the address he spoke of the "stern logic of the American experiment" having forced free schools upon the countries of Europe. What the stern logic of the American experiment teaches we are ourselves not prepared to say; but we notice that, in his annual report, Superintendent Draper tells us that one result of the American experiment is that since 1851 there has been a steady decrease in the percentage of attendance at the public schools. These are his words:

"The reports show that in 1851 the 'total attendance' comprised 75·6 per cent of the school population. This percentage has constantly fallen off with surprising regularity during the intervening forty years. In 1861 it was 65·6 per cent, in 1871 it was 68·4 per cent, in 1881 it was 61·4 per cent, and in 1891 it was 57·8 per cent. This is a showing which must engage the attention of all thoughtful persons. There should be some explanation of it, or there should be vigorous measures to remedy the growing evil of non-attendance upon the schools. Is there any explanation? Are the circumstances as unfortunate as the figures indicate? It should be said, in the first place, that the 'school population,' being all between five and twenty-one years, includes many children whose parents deem them too young to go to school, and a great many more who have gone through the schools and commenced work. In other words, the statutory school age is both younger and older than the actual school age is, or ever can be, in the greater number of cases, and is therefore misleading. This will indicate why the percentage is small, but not why it continually grows smaller."

The fact is that, since the establishment of kindergartens, children are going to school at a younger age now than they did a generation ago; and it is also the case that boys and girls stay longer at school nowadays than they used to do; so that, in the absence of other influences, the percentage of attendance ought to be higher considerably than it was in 1851. Perhaps it was that forty years ago people had not yet learned to undervalue education on account of its very cheapness. Whatever the explanation, it seems to us that "the logic of the American experiment" requires to be further explored.

THE LAW AND THE DOCTORS.

Mr. Frederic Harrison and Mrs. Fawcett have been having a little controversy of their own on the subject of "the emancipation of women." Mr. Harrison is desirous that women should have all possible educational advantages, and he says many fine things about their intellectual and moral powers; but he still holds that their place is in the home, not in the factory, the counting-house, the Government office, or the political meeting. Mrs. Fawcett points out the impossibility of confining women to the home in these days when so many of them have no home, or none that can give them a living; and, apart from that, she resents the idea that women are not adapted to extra-domestic tasks and duties. The controversy is in able hands, and we have no wish to intervene at present. One remark that Mrs. Fawcett makes, however, seems to call for a word. She

speaks of "people who are in rebellion against all order in society; who think marriages should be dissolvable at will; that parents ought to have no control over their children," and so on through quite a list of absurdities, the last being the opinion that "any quack or impostor who chooses to put a brass plate on his door calling himself a physician, a lawyer, or what not, should occupy exactly the same position as those who have entered the various professions after complying with the constituted educational test of fitness." Now, we are not acquainted with any persons, nor have we heard of any, who hold this opinion; but we do know of some who consider that if there is anything that tends to bring the capable man and the ignoramus down to a common level, it is the brass door-plate under existing conditions. The public understand now that they have a guarantee that the M. D. on a door-plate or diploma means something definite; whereas the fact is that it may cover the widest possible diversity of attainments and abilities. The present system casts a kind of mysterious sanctity round the very blunders of the authorized physician, so that good wives may be heard talking of them with bated breath almost as if they were treading on holy ground. The doctor in fact is treated in general with far more consideration and even reverence than the minister, and, so far as we can see, his science only suffers through the distinction made in his favor. Whatever Mrs. Fawcett may think of it, we are strongly of opinion that medical science will never make the progress it is capable of till it is wholly set free from state control. Instead of such freedom placing the impostor and the competent practitioner on a level, it is the very thing, we are persuaded, that would do most to drive impostors, certified and non-certified, out of the "profession."

LITERARY NOTICES.

MORAL TEACHINGS OF SCIENCE. By ARABELLA B. BUCKLEY (Mrs. Fisher). New York: D. Appleton & Co. Pp. 122. Price, 75 cents.

SCIENCE has been many times accused of having no tendency toward morality, and, in fact, of exerting an opposite influence by releasing men from some restraints that formerly held them to the path of virtue. It is true that the adherents of science have not yet been able to construct a complete system of ethics, based on the evolution philosophy, but their position has been that of a builder who is jeered at because his house has no roof before he has had time to raise its walls in the face of the hindrances thrown in his way by his critics. The old conception of the universe is a growth of tens of centuries; must the new be thoroughly worked out in a single generation? However, scientists have no disposition to shirk the ethical problem, and now that they have achieved a suitable vantage-ground are already beginning to develop a solution of it. The present volume is designed to show in a simple manner that science *does* tend to produce moral conduct, and how its moral teachings are to be looked for. The author affirms at the outset that acquaintance with scientific truth can not give us false guidance with respect to conduct. If selfishness is not the universal law of progress, she says, "we need have no fear that the study of natural laws will mislead us into believing it. With our limited knowledge we may often be perplexed, but so long as we do not overstrain the facts we shall not be confounded. If it be true that the instincts which lead us to be just and merciful, honest and unselfish, pure and affectionate, to fear moral degradation, and to aspire to nobleness of character, are inherent in the very laws of our being, then we shall find the gradual development of these qualities in the groundwork of living nature. In a word, we shall find evidence that high moral duties are not true merely because all religions have taught them, but that all religions have taught them because they are true."

The author admits no question as to the existence of God, but declares that his "*ultimate* nature and attributes" "must tran-

scend our utmost efforts of intuition or imagination." Yet, she continues, "we can not surely fail to recognize that partial manifestations of that nature are taking place within and around us at every moment of our lives." Science has revealed how the First Cause proceeds in the creation of a particular kind of plant or animal; it has shown, as no other testimony has been able to show, that "his ways are not as our ways," and that he is "without variableness or shadow of turning," and it has made men feel that every right or wrong act is sure to have its proper recompense. The presence of pain and strife in the world has long been a mystery. The great scientific doctrine of natural selection first gave a clew to their usefulness.

In both the animal and the vegetable kingdoms the author points out that species and individuals that satisfy the conditions of their surroundings flourish, while those that behave differently perish. From this she draws the lesson that in order to attain the highest life of which he is capable, man must adapt his conduct to the will of the Author of all things, as expressed in the laws of the universe. Although one's conduct is largely influenced by heredity, this is no excuse for resigning one's self to a downward course. From the very beginning of animal life we see a power of *choice* developing together with consciousness, and out of this power springs responsibility. The success and the enjoyment achieved by disregarding moral laws are only a short-lived success, and an imperfect enjoyment.

The question of immortality Mrs. Fisher deems a profound and difficult one. Regarding it as intimately connected with all higher morality, she feels obliged to state her conviction upon it, which is that "our moral nature and the conclusions of science, even apart from religious belief, all point to a continuation of individual existence beyond the few short years we pass in this world." The reasons that she gives in support of this opinion are not, however, as clearly teachings of science as are those which she finds as a basis of moral conduct. The chief argument is that persons who suffer inherited disadvantages in this life ought to have compensation. Thus it will be seen that the book accepts the main principles of religious ethics, and supplies reasons for obeying moral laws in addition to those which the most enlightened religions contain. Its influence on the adult or the young reader can not fail to be elevating, and it should prove to be a valuable text-book for the teaching of pure ethics.

PRINCIPLES AND PRACTICE OF PLUMBING. By S. STEVENS HELLYER. London: George Bell & Sons, 1892. Pp. 294. Price, $1.25.

THIS is one of the Technological Handbooks issued by the London publishers, George Bell & Sons, and edited by Sir H. Trueman Wood, Secretary of the Society of Arts. It appears to cover the subject quite completely though briefly, and contains much information that the householder would find it advantageous to know, though it is addressed primarily to the plumber. The contents of the volume range from a consideration of the metallurgy of lead and tin to the proper fixing in place of the various apparatus which it is the business of the plumber to know about.

THE ELEMENTS OF POLITICS. By HENRY SIDGWICK. London and New York: Macmillan & Co., 1891. Pp. 632. Price, $4.

PROF. SIDGWICK has undertaken in this volume a general survey of the field of politics, with the object of determining what work a government may properly undertake to do, and what form of structure is best suited to the purpose. Holding to the individualistic view of social organization as contrasted with the socialistic, and seeking his sanctions in the main in the principle of individualism, he yet departs widely at times from the *laisser-faire* school of political thinkers. He rejects the strictly individualistic test of what things a government may properly attempt to do as being inadequate, and adopts instead the "general welfare," as the test of what things are permissible and what are not. From this point of view he is able to find adequate sanction for such extensions of government activity as public education, the care and relief of the indigent, public hospitals, public parks, sanitary supervision, etc., and the carrying on of certain businesses that are semi-public in character, such as the transmission of mails and

telegrams, and the supply of water and lighting in towns.

The scope of the author's inquiry in this branch of his subject may perhaps be best indicated by the following extract:

"The legislation of modern civilized communities, then, is, in the main, framed on an individualistic basis; and an important school of political thinkers are of opinion that the coercive interference of government should be strictly limited to the application of this principle. I propose, accordingly, in subsequent chapters, to trace in outline the chief characteristics of the system of law that would result from the consistent application of the individualistic principle to the actual conditions of human life in society. I shall then examine certain difficulties and doubts that arise when we attempt to work out such a consistent and exclusive individualistic system. I shall analyze the cases in which, in my judgment, it tends to be inadequate to produce the attainable maximum of social happiness; and I shall consider to what extent, and under what carefully defined limitations, it is expedient to allow the introduction of paternal and socialistic legislation, with a view to remedy these inadequacies."

In the branch of this subject relating to the structure of a government, Prof. Sidgwick is occupied with a discussion of what he esteems the most desirable relation between the three prime departments of a governmental structure—the executive, legislative, and judicial. His discussion is well worth study, and abounds in suggestions of improvements in details as well as in principles of the more prominent features of modern governments.

THE HORSE. By WILLIAM HENRY FLOWER, Sc. D., Pres. Z. S., etc. Modern Science Series, No. II. New York: D. Appleton & Co. Pp. xiv + 204. Price, $1.

PROF. BALL'S instructive book on The Cause of an Ice Age, which opened the new popular scientific series, edited by Sir John Lubbock, is followed by the present volume, in which the structure of the most interesting of the domestic animals is described. The author begins by defining the horse's place in nature, as indicated by its ancestors, whose fossil remains have been found in considerable abundance, and by its relatives. In the second chapter the horse and its nearest existing relatives are described. These are the Perissodactyle ungulates comprising the three families, tapirs, rhinoceroses, and horses. Of these the tapirs retain more of the primitive characteristics of the common ancestors of the three families than either of the others. Of the tapirs there is but one genus. The rhinoceroses are grouped in three sections or genera—the rhinoceros with one horn, the ceratorhinus and the atelodus, each with two. The horses (family *Equidæ*) comprise the horse proper, the asses, and the zebras. Although wild horses have been abundant in both America and Europe, the nearest approach to a wild horse existing anywhere at present is the *tarpan* of the steppes in southeastern Russia. The latter half of the volume is devoted to the structure of the horse, chiefly as bearing upon its mode of life, its evolution, and its relation to other animal forms. The bones of the head and neck and the dentition are fully described, and the chief characteristics of the lips, nostrils, and neck are pointed out. In describing the cervical ligament, which is attached like a stay-rope to the neck and to the fore part of the backbone, the author takes occasion to condemn the useless cruelty of the bearing-rein. The fourth and last chapter is devoted to the limbs, and contains an interesting comparison between the arrangement of the bones in the limbs of the horse and in those of man. Twenty-six figures illustrate the text.

PRINCIPLES OF ECONOMICS. By ALFRED MARSHALL. Vol. I. Second edition. London and New York: Macmillan & Co., 1891. Pp. 770. Price, $3.

THIS well-known treatise of Prof. Marshall has undergone but slight changes in the present edition, the more important of which are pointed out by the author in his preface. The work is a general presentation of the science on the general lines laid down by the English economists, but there is to be traced in it the influence of more recent economic thought in modifying the treatment of many problems and altering the weight given to conditions and considerations not strictly economic. As Prof. Marshall points out, the

older economists were disposed to view the science too largely from the point of view of the needs and actions of the "economic man" —an ideal construction actuated only by economic motives, instead of those of the actual man, in the determination of whose economic action many motives enter besides those that are strictly economic. Paramount among these are the ethical forces, family affections, and other altruistic feelings, which in any given set of conditions are sufficiently uniform to produce conduct that may be predicted. The introduction of considerations of this kind as economic factors, while leaving the older conclusions substantially as they were, tends to give to them much less sharpness of outline, and presents economic laws more as statements of general tendencies than as a set of fixed and invariable conditions.

The book is well printed and bound and of convenient size, and is provided with marginal notes indicating the subject-matter. An appendix concerned with the application of mathematics to economic problems, and an index complete the volume.

MANUAL OF CHEMICAL TECHNOLOGY. By RUDOLF VON WAGNER. Translated and edited by WILLIAM CROOKES, F. R. S. From the thirteenth enlarged German edition as remodeled by Dr. FERDINAND FISCHER. New York: D. Appleton & Co. Pp. 24 + 968. Price, $7.50.

So great have been the changes in the chemical treatment of materials in the various industries since the author's last edition of this work appeared that the present edition is practically a new book. The eleventh edition was completed by Wagner shortly before his death in 1880. The twelfth edition, which was issued in 1886, was edited by Dr. Fischer, who cut out the matter that had become obsolete, and inserted references to recent improvements in the processes treated, but made no extensive changes. In the present edition the work has been wholly remodeled; the alphabetical arrangement of the subject-matter has been replaced by a classified grouping; new subjects have been introduced, the latest developments in old subjects have been inserted, and about half the six hundred illustrations are new.

Since fuel is indispensable in every department of technology, it is first considered, over one hundred pages being given to this subject and lighting. Both the preparation and use of heating and lighting materials are considered. The greater part of this section is new matter. In Section II, Metallurgy, a new subdivision on potassium and sodium is inserted. Section III is devoted to Chemical Manufacturing Industry, including the production of sulphur, sulphuric acid, soda, explosives, ammonia, salts of the metals, etc. New topics in this section are water, manures, and thermo-chemistry. Section IV, on the Organic Chemical Manufactures, has been written entirely anew. This chapter includes alcohols and ethers, organic acids, benzol colors and other organic coloring matters, etc. The fifth section is devoted to glass, earthenware, cement, and mortar; the sixth deals with Articles of Food and Consumption; and the seventh with the Chemical Technology of Fibers, while the eighth is a miscellaneous group, comprising the products of hides, bones, and fats, the essential oils, resins, and the preservation of wood. Thermometric, hydrometric, and other tables are appended to the volume. The translation has been carefully edited by Prof. Crookes, with the omission of some passages of merely local application and the insertion of notes and bibliographical references, making the version much more valuable to English readers than a simple translation would have been.

THE WORKING AND MANAGEMENT OF AN ENGLISH RAILWAY. By GEORGE FINDLAY, General Manager of the London and Northwestern Railway. New York: Macmillan & Co., 1891. Pp. 354. Price, $1.50.

IN this small volume of three hundred odd pages Mr. Findlay has detailed the working and management of one of the great English railways—the London and Northwestern. His description includes the financial and business as well as the mechanical operations of the road. What strikes the reader of these pages the most forcibly is the thoroughness with which all the details of operation have been worked out, and the care exercised over these details to assure the perfect operation of the road at all times. To this end the road is placed under the most detailed supervision, as well as being provided with the various modern appliances

which experience has shown are essential to safety. It is, of course, operated under the block system, without which the operation of any great railroad with its multifarious traffic can not be safe. To listen to the excuses often made by railroad officials for not adopting this system, one would get the idea that it is in some way complex and intricate and not easy of application to railway operation under all circumstances. It is, however, simplicity itself. It does not consist in any necessary forms of appliance, but is simply a method of operating. Mr. Findlay describes some simple forms of indicators used on the London and Northwestern, but any form of indicator may be used. The block system consists simply in dividing a road into a number of sections and allowing but one train at a time in either direction in any given section. To apply it to a road requires only the erection of proper signals and suitable means for operating them, and knowing their condition by the operators stationed along the line at the entrance of every block division. It is a matter of no small wonder that the officials of any considerable road should resist the introduction of so simple a method of insuring safety, and that any community should tolerate a railway service not operated in such a manner. The book is very readably written, and can be read with interest by the general public who have to make use of the railways, and with profit by not a few of our railway managers.

DISEASES OF THE URINARY APPARATUS. By J. W. S. GOULEY, M. D. New York: D. Appleton & Co. Pp. xiii+342. Price, $1.50.

CRITICISM of the substance of this treatise must be left to that very small minority of the medical profession who are familiar with the latest contributions, made in Europe and in this country, to the author's special branch of their science. It is enough to say on this subject that Dr. Gouley has here brought into one small volume everything which the well-educated practitioner, who is not yet a specialist, needs, to set him on a level with the foremost specialist in urinary surgery and medication—except experience. The physician of a scientific habit of inquiry will find it a most stimulating book; full, indeed, of the facts of observation and practice, but with each fact set forth, not as an isolated fragment of knowledge, but as an essential part of an organic system of truth. At the same time the spirit of inquiry pervades the whole. The student of the subject is taken into partnership with the teacher in the great work of advancing the boundaries of knowledge. The dogmatism which claims finality and universality for its own formulas is excluded; and every acquisition is made a stepping-stone in the way to new discovery. One hardly knows, in ending the perusal of these pages, whether the writer is most to be congratulated as the representative of the generation of reformers, who have reconstructed this important branch of medical science and placed it on a lasting basis, or as the harbinger of their successors, who will surely, by following out the same methods to far greater results, add immeasurably to its power to serve mankind.

It is rather our province to speak of the literary form of the work, which certainly deserves special notice. Technical treatises, in every line of professional learning, are so often marked by everything that is forbidding in style that it is a rare privilege to meet with one which can be treated as literature. Of course, no such work is designed for popular reading; and this one, in particular, is addressed only to students of special education and high intelligence. But its special merit is that it is perfectly adapted to its end. There is no waste of words, no tedious repetition, no looseness of statement, no parade of impertinent learning, no obtrusion of personality. Concise in style, precise in definition, clear in reasoning, orderly and progressive in arrangement, and with an accuracy and care in terminology almost without precedent, it leads on from the elements of the subject to the very border lines of contemporary knowledge in a steady march, which offers a model in plan to all who would teach subjects of difficulty. We trust that it will receive from the profession a welcome which will be an object-lesson to many medical writers; for it would be easy to name many whose books, while containing information of great value, would be doubled in usefulness, though halved in size, if rewritten after the fashion of this admirable *multum in parvo*.

TRAVELS AMONG THE GREAT ANDES OF THE EQUATOR. By EDWARD WHYMPER. With a Supplementary Appendix, bound separately. New York: Charles Scribner's Sons. Pp. xxvi+456, and xxvi+147. Price, $6.

WHETHER regarded as a book of travel or as a record of scientific exploration, Mr. Whymper's production has eminent claims to attention. The chief object of his expedition was to investigate the physiological effects of the diminished air pressure at high altitudes. That some disturbance of the bodily functions is caused by ascending to great elevations had been established by the testimony of "multitudes of persons of diverse conditions—by cultured men of science down to illiterate peasants. . . . Nausea and vomiting; headaches of a most severe character; feverishness, hæmorrhages, lassitude, depression, and weakness; and an indescribable feeling of illness—have been repeatedly mentioned as occurring at great elevations, and have only been cured by descending into lower zones. To these maladies the term mountain sickness is now commonly applied." While such effects have been felt by persons who have slowly climbed mountains to heights of fourteen thousand to fifteen thousand feet, balloonists have often risen within an hour to much greater heights without such inconvenience. This fact gives reason to believe that symptoms produced by fatigue have been attributed often to rarefaction of the air. Accordingly, in his Andean explorations, Mr. Whymper took especial care to eliminate the effects of fatigue from his observations.

The scene of his operations was that part of the chain of the Andes crossing the Republic of Ecuador, and among the mountains climbed were Cotopaxi, on the summit of which a night was spent, and Chimborazo twice, the summit being reached only in the second ascent. Many less noted peaks also were scaled. Besides making the observations which were his chief care, Mr. Whymper determined the altitudes and the relative positions of the chief mountains of Ecuador, made comparisons of boiling-points and aneroid readings with the readings of the mercurial barometer, and made botanical, lithological, zoölogical (chiefly entomological), and archæological collections. As stated in the introduction, he concerned himself "neither with commerce nor politics, nor with the natives and their curious ways." Yet the incidents of the expedition, which are plentiful and are recounted with much vividness and humor, tell not a little about the "curious ways" of Ecuadorian bipeds and quadrupeds, likewise of hexapods and centipedes. The baggage-mules were inexhaustible mines of original sin, and the insects in the lower regions were everywhere. One full-page plate crowded with figures of flying and creeping things is described by the author as "selections from my bed-fellows at Guayaquil." The volume is copiously illustrated with carefully drawn and engraved pictures, many of them from the author's photographs. The meteorological observations are appended to the main volume. In the supplementary volume Mr. Whymper's zoölogical collections are described, with illustrations. They include a goodly number of species which were new to science.

The *Chinese Scientific and Industrial Magazine*, John Fryer, LL. D., editor, is now in its sixth volume. Its purpose is to convey to intelligent Chinese a knowledge of the principles and progress of Western science and art. It contains, quarterly, one hundred pages of matter, printed in the best Chinese style, liberally illustrated, relating to subjects of practical as well as theoretical interest. In the number before us such subjects are treated as photography, the art of living long, sugar-making, therapeutics, pressing, drawing, shearing, and stamping machinery, electricity, materia medica, ice-making machinery, the manufacture of lucifer matches, dual consciousness, electric railroads, Edison's kinetograph, and mathematical problems. Presbyterian Mission Press, Shanghai; Ralph Waggoner, 10 Spruce Street, New York. Price, $1 a year.

Dr. *John Aulde*, acting upon the belief that with the better knowledge of the physiological action of drugs large doses are not needed to produce desired clinical effects, has prepared *The Pocket Pharmacy*—a book intended both for practical use and as a plea for small doses, to be administered in accordance with physiological deductions. We are learning, he holds, instead of the gross manifestations of disease, to regard more closely the derangement of cell function on

which they depend. Having acquired this knowledge by studying the pathological changes occurring in disease, we endeavor to discover remedies which, by their known physiological actions, would be calculated to arrest or counteract those changes. This leads to the study of the effect of medication on the diseased cell, and logically to the conclusion that small doses are to be preferred. The present work is the outgrowth of personal experience in practice, and it is adapted to use with the pocket case. It contains a list of remedies, with the diseases to which they are suited, and a therapeutic index of diseases with reference to the remedies prescribed for them. (D. Appleton & Co., publishers.)

A hand-book on *Chemical Calculations* (New York: Longmans, Green & Co., 60 cents) has been prepared by Mr. *R. Lloyd Whiteley*, to supply a need for a work giving, besides a fair selection of problems, a concise and yet explicit account of the methods of solving them. It is intended to form a part of the course of teaching or study suitable to the chemical student who wishes to prepare himself for whatever duties in his line he may be called upon to perform, and is also an aid to examinations. A short summary of chemical facts or processes is given before explaining methods; and the explanations concern methods of calculating the results of specific gravity determinations, of analyses of all kinds, and of atomic and molecular weight determinations, and are brought up to date. The author is a laboratory teacher and a lecturer on certain special branches of chemistry, and brings the results of his experience and of his intercourse with students to aid in his work. Prof. F. Clowes furnishes the preface.

A translation of Dr. *Walther Hempel's Methods of Gas Analysis*, made by Prof. L. M. Dennis, of Cornell University, is published by Macmillan & Co. It has been the purpose of the author, omitting the complete description of known methods, which would make the book too bulky for a laboratory guide, to describe his own researches and the construction of apparatus, and all the operations which are involved in the analysis of gases with his apparatus. The apparatus devised by Pettersson has been described because a wholly new principle in the measurement of gases is there brought into use. In the translation, which has been made with the personal co-operation of Prof. Hempel, the chapter upon the determination of the heating power of fuel has been largely rewritten, with the introduction of new cuts of the latest forms of apparatus, the chapter upon the analysis of illuminating gas has been changed, and a new method for the determination of the hydrocarbon vapors has been inserted. Price, $1.90.

In the treatise of *R. Lovett* and *C. Davison* on *The Elements of Plane Trigonometry*, the subject is divided into three parts, dealing, respectively, with arithmetical, real algebraical, and complex quantity. Such an arrangement appears to the authors to be a natural one, and has the advantage of introducing the new names and formulæ that belong to the subject before the student encounters the difficulty of the application of signs to denote the sense and direction of lines. The work differs mainly from those most generally read in the extent to which the treatment adopted by Prof. De Morgan, the influence of whose writings appears throughout it, has been followed. Abundant examples for exercise have been collected from university and other examination papers. Published by Macmillan & Co. Price, $1.60.

A book on the *Essentials of Physics* has been added to the series of *Saunders's Question Compends* (W. B. Saunders, Philadelphia), by Dr. *Frederick J. Brockney*. It has been prepared especially for students of medicine, and is intended to be a compromise between such books as Ganot's, which is found too large to be used as a text-book, and some elementary books on the subject which do not contain all that is necessary for the student to know. The questions are classified as On Matter and its Properties—Solids, Liquids, and Gases; On Heat; On Light; On Sound; and On Magnetism and Electricity. Price, $1.

Mr. *David Denning's* hand-book on *The Art and Craft of Cabinet-making* (Macmillan, $1.50) will be welcomed by amateurs and young craftsmen, and even experienced workmen may derive pleasure and profit from it. It relates to the construction of cabinet furniture, the use of tools, the formation of joints, etc., explaining the ordinary reliable methods of the workshop, but not exploiting

novelties in style or processes. It marks the distinction between cabinet-making and joinery, and between cabinet-making and decoration; gives a review of the development of furniture, in which the tricks and deceits of a class of dealers in pretended antiques are exposed; and then furnishes practical information, with more than two hundred illustrations, concerning the various matters pertaining to cabinet-making—furniture woods, glue, nails, tools, wooden appliances made by the user, grinding and sharpening tools, joints, structural details, construction of parts, drawing, veneering, etc., and the construction of various articles.

Mr. *J. Traill Taylor's* manual on the *Optics of Photography and Photographic Lenses* (New York: Macmillan & Co., $1) is practical rather than theoretical, and is intended for the users of photographic lenses. It includes the substance of articles furnished to the photographic journals and photographic clubs of Great Britain. It furnishes brief accounts of the nature and properties of light, the principles on which the use of lenses is based, their defects and the means of remedying them, the different classes of lenses; the methods of preparing, mounting, fitting, and using them; and such other information as the photographer needs respecting them. The author distinguishes the optics of photography from that of the telescope or microscope by showing that the former takes cognizance of rays transmitted obliquely as well as axially, and brings both the chemical and visual rays to a focus on the same plane.

A book, small enough to be carried in the pocket and convenient for reference at any time, entitled *American Citizenship and the Right of Suffrage in the United States*, has been compiled by *Taliesen Evans*, and is published by him at Oakland, Cal. It comprises abstracts of national and State laws affecting citizenship and suffrage in the United States, and of such questions relating thereto as have from time to time been passed upon by the courts. The effort has been made to treat the subject in such a way as to make the presentation acceptable and instructive to the American student, and interesting and useful to persons of foreign birth who desire to become citizens and voters. It includes general reviews of the conditions of American citizenship and of the right of suffrage; literal quotations of the constitutional provisions of each of the States concerning the qualifications of voters; a chapter on the qualifications for holding office; and the Constitution of the United States.

The Rev. *Emory Miller*, D. D., LL. D., apparently endeavors, in a book on the *Evolution of Love*, to approach the deepest questions of divinity. Superstition, opinion, and discrimination, he says, are three epochal words, of which the first has had its day and the second its noon, while the sun of discrimination is dawning. Casting away superstition, refusing to be bound by opinions, the author tries, he says, honestly and by the method of discrimination, to seek the truth. In this spirit he discusses the Implication of Being as perceived, as conceived, and as conditioned, and finds perfection of Being in perfect love. He next discusses Creation, with the conclusion that it is an indulgence of love's eternal, altruistic spirit; finds the origin of evil in selfishness, and its solution in conditions within which it is held that provide for either its merciful remedy or its self-extinction. The last chapters relate to The Atoning Fact, The Revelation of Atoning Fact, and Eschatology, or the doctrine of "last things." Chicago: A. C. McClurg & Co. Price, $1.50.

The Bureau of Education has issued a Circular of Information on *Sanitary Conditions for School-houses*, the result of an extended study of this subject by Dr. *Albert P. Marble*, of Worcester, Mass. This monograph is concerned with practical devices for ventilation and heating, drainage and lighting. Appended to the body of the circular are papers on Ventilation of School-houses heated by Stoves, Hygienic Construction of the Bridgeport High-school Building, Worcester School Buildings, Plans and Specifications of School-houses prepared for the Wisconsin State Bureau of Education, and Designs for School-houses accepted by the Department of Public Instruction of the State of New York. The whole document is copiously illustrated; the main portion has twenty-three figures in the text and seventy-one plates, showing heating apparatus, the arrangement of ventilating ducts, the course of heated air through rooms, sanitary closets, etc. The appendixes are accompanied by

eighty illustrations, showing plans and views of school-houses, and arrangements for heating and ventilating.

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POPULAR MISCELLANY.

Possibilities of Wheat-raising.—Within twenty years, according to a bulletin of the State Agricultural Experiment Station, the area annually sown to wheat in Ohio has increased from an average of 1,800,000 acres during the eighth to 2,500,000 acres during the ninth decade. This area represents twelve per cent of the area in farms within the State; but several counties are sowing annually from eighteen to twenty and even twenty-five per cent of their farm-lands to wheat. A further increase in acreage is anticipated from the clearing away of more forest and the reclamation of waste lands by drainage, so that it will be possible to devote 3,000,000 acres to wheat without interfering with any other agricultural interest. Such an increase, at the present rate of production, would represent an annual crop of 40,000,000 bushels. But it is not to be supposed that Ohio farmers will rest content with a yield of only thirteen bushels of wheat per acre. The northern third of the State has increased its average yield within forty years by nearly three bushels, and the middle third by from one to two bushels, and it is reasonable to expect a further increase within the next forty years. At the average already reached in Summit County, the whole State would produce about 60,000,000 bushels, or bread for twelve million persons. What is true of Ohio is true, to a greater or less extent, of the entire winter-wheat belt of North America. The area now sown to wheat in this region may be expanded largely without infringing upon other productions, and the rate of yield may and will be very materially increased by better husbandry, including an intelligent use of manures and fertilizers, and more thorough drainage. The profitable culture of wheat on the steep hillsides of southern Ohio appears to be hopeless. The great problem before the grower in the central belt of counties is winter-killing, but it may be partially solved by under-draining and the intelligent use of clover and manures. The influences are more generally favorable to wheat culture in the northern counties than elsewhere in the State. A general improvement in the methods of agriculture appears to have contributed more largely to the increase of the wheat crops than the use of commercial fertilizers.

Distribution of Diphtheria.—A paper by Dr. Samuel W. Abbott, Secretary of the State Board of Health, on the Distribution of Diphtheria in Massachusetts, brings out some curious results from an examination of the conditions in the several parts of the State in which the disease has prevailed during the past eighteen years. The town which suffered relatively most of all was Florida, a hilly town of small population, situated over the Hoosac Tunnel. Next to it was Spencer, an interior town of Worcester County, having a comparatively dense population (7,466 in 1880), mostly engaged in the shoe manufacture. The third town in the list was Freetown, with 1,329 inhabitants in 1880, adjoining Fall River, and situated on low and sandy ground. Other towns that suffered greatly were Adams, Williamstown, and Hancock, on high land; Webster, a manufacturing town on comparatively low land; Ayer, and Nantucket. Four towns had no deaths from diphtheria during the period under consideration. They are all small towns, distant from railroads, and not visited by the general public. Dividing the towns and cities according to the density of their population, the author found that the average annual death-rate from diphtheria and croup in ninety-two densely settled towns and cities was 11·39 per 10,000 of the population, while that of two hundred and fifty-four rural or sparsely settled towns was 6·53 per 10,000 for the same period. Out of the twenty-eight cities, twenty, including all of the most populous, except Fall River, had a death-rate from diphtheria and croup higher than the average of the State. Divid-

ing the counties into three groups—those in which there were, respectively, $\frac{1}{100}$ of an acre, 1·4 acres, and 4·8 acres to each person, the corresponding rates of mortality from diphtheria and croup were 12·7, 10·2, and 8·8 annually for every 10,000 persons. The relation of certain railway lines to the diphtheria death-rate is worthy of note. It was comparatively high in the greater number of cities and towns traversed by the Boston and Albany Railroad—a leading road for traffic, carrying large numbers of passengers, and having many stations; was less upon the line of the Fitchburg road, which is of about the same length but does less business; and still less upon the line of the more recently built Massachusetts Central road. The term *diphtheria* first appeared in the registration reports of the State in 1858. The number of deaths assigned to it increased rapidly till 1863, when 1,420 were registered. There was then a rapid decline to 251 in 1867, after which the annual number continued nearly uniform (about 275) for seven years, when it rose again to 2,610 in 1876 and 2,734 in 1877. The census of 1890 gave the number of deaths as 32,716. The diphtheria death-rate bore no relation to the general death-rate, except during the period from 1862 to 1867. In 1872, when the general mortality-rate was at its highest point and infectious diseases were generally very prevalent, the diphtheria death-rate was far below the mean, and in 1876 and 1877, when the general death-rate was near the mean, the diphtheria death-rate was at its highest point. The author concludes, further, that diphtheria is eminently contagious; that it is infectious by direct exposure and through indirect media, but less so than some other diseases, such as small-pox and scarlet fever; that overcrowding, faulty ventilation, and filthy conditions favor its spread; that the direct influence of plumbing and transmission through public and private water-supplies is not proved; that its propagation is favored by soil moisture, damp cellars, and general dampness of houses; and that the poison may remain dormant in houses for a long period.

Scientific Observation of Children.—In a paper on this subject addressed primarily to mothers, Mrs. Helen Adler has laid out a plan of work of considerable scope, and calling for the exercise of careful judgment. Mothers, the author says, "must first of all learn to appreciate the value of true scientific observation, must train themselves to observe correctly, methodically. They must humbly learn that their own powers of appreciation are worthless without the strict selection of valuable facts, the subordination of what is interesting and delightful to them to the universally interesting and profitable. . . . Method, strict, logical method, is the first desideratum; then vigilant observation, veracity, discrimination, and ingenuity in the study of the child. Baby ways are charming and irresistible; they will be no less so when an attempt is made to discover the order of progress that dwells in them." The development of language alone is mentioned as offering a fascinating field of observation; the study of the baby will and its evolution another; and the psychic life of the child will seem somewhat nearer to us, the growth of its faculties a little more clearly revealed, if we trace the record of their development day by day. Later in life comes the development of the character of the child as a social being. A practical direction is given to these observations by appending to them a classified schedule of the points to which attention may be directed.

Olives and Olive Oil.—The olive is cultivated on about seventy thousand acres in the department of the Alps Maritimes, France, and yields a revenue of more than two million dollars a year. Two species of the tree are described by our consul at Nice as growing in the south of France: the *oleaster*, or wild olive, which has a kind of thorn and very short leaves, and produces only a few small berries, which appear to be proof against insect enemies; and the *sativa*, or cultivated olive, which produces a large fruit, and is known in several varieties. The olive tree flowers every year; but, while some growers advocate an attempt to gain a yearly crop, the majority are content to try to get a good crop every two years. Olives to be preserved green are plucked in September; those destined for oil, from November till the following May; but the best results to crop and tree seem to follow harvesting near mid-winter when the olive is black; while oil made from olives gathered as late as February and

March is preferred for its keeping properties. The mill in use at the present day to crush the olives differs but little from those which have been used for centuries. A mill has lately been invented which, as it crushes the pulp, extracts the stone and throws it out, thus allowing the pulp, the true virgin oil, to be obtained from the press without any admixture of that obtained from the stone or kernel. To prepare virgin oil, olives are taken, free from blemish, when only three quarters ripe, slightly crushed, with care that the seed be not touched by the millstone, then placed in a heap so arranged that the oil shall run out of itself and be collected. Oil thus prepared is greenish, has an exquisite perfume, and can be kept for many years. A second quality of oil is extracted by the aid of water; and after all the usual means of extracting the oil from the pulp have been employed, ten per cent of oil can still be obtained by using bisulphide of carbon. After the oil is extracted, the skins and refuse are employed in heating boilers; the muddy substance found at the bottom of the most inferior quality of oil is used as manure; and the broken stones, or *grignons*, make an excellent fuel.

The Pace of Mind.—The appearance of a new quickly calculating man, Jacques Inaudi, a Piedmontese, in Paris, has suggested the inquiry, What is the nature of the power that gives men of this kind their remarkable faculty? The Spectator suggests that such cases are abnormal instances of the difference in pace which we all know exists between the working of different and even of equal minds. "Everybody who has studied his acquaintance at all," it says, "knows that this difference is very great; that one man can comprehend an interrogation in half the time taken by another; that no two children are alike in quickness of thought, as distinguished from accuracy or depth of thought; and that clever women constantly reach results, which can only be reached by their thinking more rapidly than men." The difference is especially marked in mental arithmetic; and the difference, though it can be affected by practice or neglect, is ultimately independent of both. Inaudi was asked to mention the day of the week on which a given date would fall some years hence, and answered accurately, Monday. It is not to be supposed that he guessed, for he had done the like before, and there was no ground for assuming collusion; then "his mind must, say, in three seconds, have traversed a calculation which it would take the few men who could do it in their minds at all, many minutes. Such pace is almost unthinkable, even if we remember that, the date on which this day falls in this year being once ascertained, the rest of the problem is only a swift effort of memory, the days advancing in a regular sequence, accelerated by leap-years; but still, superior pace is a theory which does meet all the conditions." The existence of differences in the pace of mind being conceded, the question next arises whether speed can be cultivated. If it can, we have a way pointed out by which intelligent life may be rendered longer and fuller. Dr. Martineau is said to believe, what many other persons fancy, that the English middle class has in the last two generations gained so greatly that the gain is perceptible in mental quickness. The Brahmans of India are celebrated for their superiority in this faculty. Teachers admit that the children of the educated poor are easier to teach than children of the uneducated poor; that "they have not only more 'receptive minds,' which may mean only better memories, but that their minds move positively quicker." On the other hand, the English educated never seem as quick as the Irish uneducated.

The Destiny of Sea-coast Land.—Among the results of his examination of the provisions of the shore towns of Massachusetts for public places of resort, and the industries and resources of the people, Mr. J. B. Harrison says, in Garden and Forest, that he found "everywhere recent changes in the ownership of land and a movement of people of means from the cities and the interior of the country to the shore regions of the State. I found leagues and leagues together of the shore line all private holdings, without a rood of space in these long reaches to which the public has a right to go. . . . I found a great population inland hedged away from the beach, and all the conditions pointing to a time, not remote, when no man can walk by the ocean in Massachusetts without payment of a fee, as we formerly had to pay

for glimpses of Niagara. I could see that the movement for open spaces for public resort has vital relations to civilization, and has been instituted in response to a pressing need." In view of the changes in industrial conditions that are likely to take place under these circumstances, Mr. Harrison finds one resource which has received comparatively little attention of late—the soil, which in most of the shore towns appears to be much better than the popular estimate of it. "It has greater capabilities than are yet recognized. This is especially true of the Cape Cod country. The soil there is better than that of southern New Jersey; and I have seen many Massachusetts men in Dakota, Montana, and Idaho, trying, in great privation, to make a living in regions more forlorn and hopeless than any part of the shore country of the Old Bay State. . . . I think these towns might yet support a great population by a highly developed agriculture and horticulture, and that owners of the land might wisely keep it and cultivate it."

Snow Effects in the Pamirs.—The region of the Pamirs, or the roof of the world, in central Asia, where the empires of Russia, India, and China corner upon one another, consists of a succession of long, broad, open valleys, running approximately parallel to each other in a general direction from northeast to southwest, and separated by low (for that region) ranges of mountains. The climate is very severe. The lowest point of the Pamirs is 10,300 feet above sea-level, and their usual average is from 13,000 to 14,000 feet. Hence the cold must be very intense. Captain Younghusband, while he had no experience of the winter weather, found temperatures at the end of October and beginning of November of 18° Fahr. below zero. Some interesting snow phenomena were witnessed by this explorer. He has looked at a mountain-peak, and then, a few moments later, seen it gradually disappear; and only by closer observation could he make out that it had been overshadowed by an imperceptible snow-storm. "The snow, indeed, in these mountains was often very fine, and almost like dust; and a very beautiful effect is, that it nearly always falls in perfect little hexagonal flakes, like little stars of lacework, each one quite distinct, and remaining intact until it reaches the ground; then, as it has fallen, the snow of course remains white on the surface, but, digging into it, appears of a beautiful delicate pale-blue color. Another effect of the snow is seen at the mountain-tops, when the peaks seem to be fading away, and vanishing off like clouds of whitened smoke. It is produced by the high wind blowing away the fine dust-like snow at the summits. Again, another almost similar phenomenon on the mountain-tops is that of long, level clouds, like streamers, flowing away from the peaks. The moisture-laden air from the plains of India has been condensed on the icy mountain summits, and the wind has blown the mist away in a long, thin streamer." Another effect of snow-particles glittering in the air in clear sunlight is also common among us on very cold winter days.

The "Down-below People."—The Havesu-Pai, otherwise known as the Koxoninos, or Cochnichnos, are a dying race of Indians, their numbers being estimated at less than two hundred souls, who were visited a few years ago by Mr. Benjamin Wittick. Dr. R. W. Shufeldt, seeking for information about them, has found that very little is known concerning them, but was able to obtain two photographs taken by Mr. Wittick, illustrating their general appearance and the style of their huts. They exist in one of the grandest cañons in Arizona, living along the banks of the stream that passes through it. Their name, which is given them by the Yumas, means the "down-below people," or a tribe or race that live down in the cañon. They call themselves the "Ah-Supai." The cañon in which they dwell is that of Cataract Creek, is forty-five hundred feet deep, and the stream tumbles by a series of cascades into the Grand Cañon of the Colorado, fifteen hundred feet deeper. The Indians raise, according to Captain John G. Bourke, fine peaches and good corn and melons, and weave fine and beautiful baskets. They are great hunters, and live by trading off buckskins and sometimes mountain-lion pelts to the Moquis, Navajos, and Apaches. Mr. Frank H. Cushing describes their home as in a green, moist plain of sandy soil, nearly two miles long by half a mile at its greatest width, of which he could catch only occa-

sional glimpses through the rank growth of willows with which the trail was lined. "These glimpses, however, revealed numerous cultivated fields of corn, beans, sunflowers, melons, peaches, apricots, and certain plants used in dyeing and basket-making, and usually carefully protected by hedges of wattled willows or fences of cottonwood poles. Everywhere these fields were crossed and recrossed by a network of irrigating canals and trails. Here and there were little cabins, or shelters, flat-roofed, dirt-covered, and closed in on three sides by wattled flags, canes, and slender branches, while the front was protected by a hedge like those of the fields, only taller, placed a few feet before the house, and between which and the house burned smoky fires. The houses were always nestled down among the thick willows bordering the river, or perched on some convenient shelf, under the shadows of the western precipices." Little buildings of stone laid in mud plaster, somewhat like the cliff dwellings, were also seen in the horizontal cracks of the western cliffs, often high up. These Indians have medicine-men, use the sweat-house, possess many dogs, have considerable families, and are on good terms with the whites.

The Purposes and Arrangement of Museums.—The museums of the future in this country, says G. Brown Goode, "should be adapted to the needs of the mechanic, the factory operator, the day laborer, the salesman, and the clerk, as much as to those of the professional man and the man of leisure. It is proper that the laboratories be utilized to the fullest extent for the credit of the institution to which they belong. No museum can grow and be respected which does not each year give additional proofs of its claims to be considered a center of learning. On the other hand, the public have a right to ask that much shall be done directly in their interest. They will gladly allow the museum officer to use part of his time in study and experiment. They will take pride in the possession by the museum of tens of thousands of specimens, interesting only to the specialist, hidden away perpetually from public view, but necessary for purposes of scientific research. These are foundations of the intellectual superstructure which gives the institution its standing. Still, no pains must be spared in the presentation of the material in the exhibition halls. The specimens must be prepared in the most careful and artistic manner, and arranged attractively in well-designed cases and behind the clearest of glass. Each object must bear a label, giving its name and history so fully that all the probable questions of the visitor are answered in advance. Books of reference must be kept in convenient places. Colors of walls, cases, and labels must be restful and quiet, and comfortable seats should be everywhere accessible, for the task of the museum visitor is a weary one at best. In short, the public museum is, first of all, for the benefit of the public. When the officers are few in number, each one must of necessity devote a considerable portion of his time to the public halls. When the staff becomes larger, it is possible by specialization of work to arrange that certain men may devote their time uninterruptedly to laboratory work, while others are engaged in the increase of the collections and their installation."

The Technical School at St. Etienne, France.—At the technical school in St. Etienne, France, according to the United States consul in that city, three hundred students are taught weaving, dyeing, sculpture, iron-founding, cabinet-making, and other arts, free of charge. The apprenticeship course lasts four years, and after completing it a certificate of aptitude is given, under which the pupil may obtain a situation in the line of industrial labor he has chosen. In the first year the students pass through all the workshops, to be initiated into the proper handling of the different tools. After that, the boys are classed according to their tastes, desires, and aptitudes. They work at manual labor three hours daily during the second year, four hours in the third, and five hours in the first and seven in the last six months of the fourth and last year. Great attention is paid to the teaching of the theory of the different trades, the fitters being taught to trace and cut out cog-wheels, and the carpenters to design and execute a certain number of works, such as stairs of different kinds, shutters, balconies, etc., on a reduced scale. The weavers are also given special lessons in book-keeping,

legislation, commercial geography, and one of the modern languages. Careful attention is paid to design.

Embroidering by Machinery.—The recent invention, at Arbon, of a new steam machine for making embroideries threatens, says Consul Byers, of St. Gall, to revolutionize some of the most important manufacturing interests of the Swiss Republic. Eastern Switzerland, with St. Gall as a center, has been for a hundred years the headquarters of the embroidery industry of the world. Embroidery by hand alone had been practiced when the present hand-machine was brought into use in 1827. Under the former system the technical skill and readiness of hand of the Appenzell women were marvelous, and the embroidery made by them became famous all over the world. At the present day possibly not five per cent of the embroideries are made exclusively by hand. The Schiffli steam machine, invented about fifteen years ago, produces a low class of goods of inferior quality. For the more recently invented Arbon machine its owners claim that it will at least triple the product of the hand-machine, that it can produce goods cheaper, and can turn them out of better quality than the old method, and do it without so much wear and tear to the muscles of men and women.

The Puma.—The puma (*Felis concolor* of Linnæus), known also as the panther, painter, cougar, American lion, and by several other names, is, according to Mrs. Frederick W. True, the only large, unspotted native American cat. It varies much in color, and is from five to seven feet long. The area over which it ranges extends from New England and British Columbia to the straits of Magellan. On the Atlantic coast the species has apparently not been found in New Hampshire, Rhode Island, New Jersey, or Delaware. No mention appears of its having been found in Michigan or Indiana. It was extirpated in Ohio before 1838, and probably more recently in Indiana and Illinois. With these exceptions, and Nevada, there are recorded instances, more or less numerous, of the occurrence of the puma, since the beginning of the century, in every State and Territory of the Union. Regarded as a species, the puma possesses in a remarkable degree the power of adapting itself to varied surroundings. It endures severe cold during the winter in the Adirondack Mountains and other parts of our northern frontier, and hunts its prey in the snow. It is equally at home in the hot swamps and canebrakes and along the river-courses in our Southern States. In South America it inhabits the treeless, grass-covered pampas, as well as the forests. In the Rocky Mountains it ascends to the great altitudes at which the mountain sheep are found; and it is also met with high up on other ranges. It selects for its abode such spots as afford some shelter, but is found in the thickets and copses rather than in the great forests. It seeks its prey chiefly at dawn and twilight and under cover of night, but sometimes also hunts by day. Deer are its principal quarry, but it also preys upon the smaller mammals and on wild turkeys. Of the larger domestic animals, such as the horse and cow, it attacks only the young, but it will carry away a full-grown sheep from the fold, and in South America often preys upon the llama. It does not ordinarily attack men, but is disposed to flee from them when surprised; but such attacks have been known. Like the cat, it scratches the bark of trees, purrs when satisfied, and has been heard to mew.

Influence of the Indian Trade.—As to the effect of the Indian trading post, Mr. Frederick J. Turner says, in a paper on The Character and Influence of the Indian Trade in Wisconsin, of the Johns Hopkins Historical and Political Science Series, that, giving him iron and guns and a market for furs, it tended to prolong the hunter stage; leaving the unarmed Indian at the mercy of those who had bought firearms, it caused a relocation of tribes and a demand for the trader by remote and unvisited Indians, made the savage dependent on the white man's supplies, and gave the Indians means of resistance to agricultural settlement. On the side of the white man, the Indian trade gave both French and English a footing in America, invited exploration, and fostered the advancement of settlements as long as they were in extension of trade. In Wisconsin the sites of the principal cities are the sites of the old trading posts, and those earliest fur-trading set-

tlements furnished supplies to the farming, mining, and lumbering pioneers. Reports brought back by the individual trader guided the steps of the agricultural pioneer. The trader was the farmer's path-finder into some of the richest regions of the continent. In Wisconsin, at least, the traders' posts, located at the carrying-places around falls and rapids, pointed out the water-powers of the State. The trails became the early roads. "An old Indian trader relates that the path between Green Bay and Milwaukee was originally an Indian trail and very crooked, but the whites would straighten it by cutting across lots each winter with their jumpers, wearing bare streaks through the thin covering, to be followed in the summer by foot and horseback travel along the shortened path. The process was typical of a greater one. Along the lines that Nature had drawn, the Indians traded and warred; along their trails and in their birch canoes the trader passed, bringing a new and transforming life. These slender lines of Eastern influence stretched throughout all our vast and intricate water-system, even to the Gulf of Mexico, the Pacific, and the Arctic Seas, and these lines were in turn followed by agricultural and by manufacturing civilization."

French Silk-weaving Centers.—According to the United States consular clerk at Lyons, the geographical position of silk-weaving in France has undergone considerable changes since the introduction of the industry. Cities in which silk-weaving was formerly of great importance, have turned their attention toward other industries, while new centers have sprung up and attained more or less prosperity. Tours was the first great silk-weaving center of France, but its industry in this line has been declining for the last sixty years. Nîmes was likewise one of the early centers, and reached great prosperity in the eighteenth century; but it has now less than one sixth as many looms as it had then. About twenty-five thousand looms are employed in Paris and the adjoining districts in weaving silk and silk-mixed goods, galloons, fringes, cords, and other varieties of *passementerie* and trimmings. Nets, tulles, and laces constitute the specialties of Calais. Whenever the demand for silk nets is low, the manufacturers substitute cotton or wool on their looms. During the latter half of the present century Roubaix has become the center of an extensive industry, manufacturing silk and wool and silk and cotton-mixed goods. These articles, though often wanting in originality, find ready sale on account of their low price. At Saint-Chamond, silk-weaving has been established in a modest way ever since the thirteenth century; and by confining their attention to braids and similar articles, the manufacturers have advanced their specialties to a degree of excellence that has established for them a world-wide reputation. At Saint-Etienne the weaving of ribbons is carried on, with great variations in the value of the yearly manufacture. Lyons is considered the most important silk center of France, and of Europe as well. Its total production averages about $80,000,000 a year. The quantity of goods produced is now greater than ever before, and constitutes two thirds of the production of France, and one quarter of the total production of the world.

Swiss Watch-making.—The Swiss watch industry is chiefly situated in the west of Switzerland, where the French language is spoken, and particularly in Geneva, Vaud, the canton of Neutchâtel, and the Bernese Jura. An ingenious labor organization has sprung up there, which combines at once the advantages of principal and minor industry. Composed of small workshops, grouped in a given region, it is under the control of a manufacturer who gives orders to the workman, and supplies him with the necessary materials, and, when the watch is finished, effects a sale. Under this system the master has not the general expenses of a factory, and the diminution in production and holidays affect him but little. In his turn, the operative working at home has a particular part of the watch to construct. He is both journeyman and foreman, who combines his dwelling with his shop. Paid by the piece, he works at his leisure from early in the morning till late at night. Such a system, which allows the wife to assist in the labors of the husband, and the children to be initiated by an easy apprenticeship into the manufacture of a special part of the watch, must suit the mountaineers. They preserve their intelligence, realize often large profits, and by the intel-

ligent practice of industrial art improve their social status. Little by little the heads of business houses have drawn into their locality a large number of families from the rural districts, and in the mountains, at one thousand metres altitude, and on the plains where only the abundant pasturage affords a means of livelihood for the native, towns have risen rapidly—for instance, Chaux de Fonds, Locle, and Saint-Imier. Thus, the system of collective industry, with work at the domestic hearth, has formed several generations of watch-makers. But, for thirty years, competition, and particularly American competition, has necessitated the erection of works with mechanical appliances.

The Sources of Gutta Percha.—Of the various kinds of gutta-percha, only those produced by trees of the old genus *Isonandra*, now sunk in *Dichopsis*, are available for use as insulators of cables. Their natural habitat is exclusively in the Malayan region. The destruction of this zone of forests proceeds rapidly. The natives cut every available tree, and repeat the process as fast as the plants spring up again. The scanty plantations started in the East Indies are, moreover, not formed of the best species, but of those which yield an inferior product. The best species has, in fact, become excessively rare, but is still in existence. Its adult representatives were yet propagating themselves in 1887 at the Chasserian estate in the ravines of the ancient forest of Boukett Tinah, in the center of Singapore. When M. Sérullas, of Paris, found the spot in 1887, gutta-collecting had ceased for thirty years.

The Kanjutis.—The Kanjutis, of Hunza, the robber tribe of the Pamir table-land, inhabit the deeply cut valley which runs from the apex of central Asia, where the Hindu-Kush and Himalaya systems meet, and the water-shed between eastern and western Asia joins that between northern and southern Asia. Captain Younghusband found them to be small, well-built, hardy, determined, though not fierce-looking men, wearing long black curls, which gave them a very wild appearance. Perhaps the most remarkable feature about them is their capacity for endurance. "They issue from their strongholds on their raiding expeditions, and cover often two hundred miles of mountainous and uninhabited country, entirely on foot, and carry their own supplies for the whole distance on their backs; and I have known cases of men carrying news of my movements to their chief in an incredibly short time. Dressed in long cloaks of thick, home-made woolen material, they sleep out in the open in the most intense cold, and yet live upon almost nothing. They are also very avaricious, although they know and care little for money; but they covet goods greedily."

A Stronghold of Birds.—The Bird Rocks, or Three Islands of Birds, near Newfoundland, were so resorted to by gannets in Audubon's time that their tops seemed covered with snow. The birds were then much used for bait, and Audubon's captain told him that his boat's crew had once killed six hundred and forty of them in an hour, with no better weapons than sticks. Up to 1860 they covered the tops of the rocks and many of the ledges on the sides. The erection of a lighthouse on the Great Rock, in 1870, was followed by a rapid decrease in numbers. In 1881 Mr. Brewster found the birds on the Great Rock confined to the ledges along the sides, while the Little Rock was still densely populated. In 1887 not a gannet was raised on the Little Rock, although a few were breeding on the pillar of rock adjacent to it. The murres, razor-bills, and puffins, Mr. Frederick A. Lucas believes, have probably suffered somewhat less than their more conspicuous comrades, although even among them the decrease must have been very great. Still, their smaller size, and consequent ability to breed in crevices of the rocks and on ledges too narrow to accommodate a bulky gannet, has been of great service to them; while the razor-bill also seems to be learning by experience the desirability of putting an egg out of sight whenever practicable. The puffins find safety in their burrowing habits, and breed extensively in the decomposed sandstone at the northeastern portion of the Great Rock, as well as under the overhanging inaccessible ledges of the northern side of the Little Rock. The little rocky pillar already mentioned is well occupied by birds of various species, and, owing to the difficulty of scaling the rock, the little colony is fairly secure. But, from its size,

the precipitous nature of the sides, and the fact that only one landing lies contiguous to the breeding birds, the Great Bird Rock must ever remain the stronghold of this interesting colony of sea-fowl. There is no regular division of the birds into large colonies according to species, but the separation is rather by size, gannets occupying the highest and broadest ledges, and murres and razor-bills taking what is left.

A Buddha, and its Meaning.—A bronze Buddha in the United States National Museum, as described by Charles De Kay, is thirty-eight inches and three quarters, or including the halo, seventy inches high, has a bronze halo, and differs from the famous seated Buddha at Kamakusa in size and in the position of the forefingers. These do not touch each other along the two upper joints, but lie one within the other. A slight trait of this kind is of the greatest importance to a Buddhist. It marks the difference between figures of the greatest of all Buddhas at the moments of his ecstasy or absorption into the Nirvana, or it distinguishes the Buddha from foreign or local saints who have presumably reached Buddhahood by meritorious pondering. The figure has the famous knob on the forehead, about which many legends revolve; also the short round curls over the head, supposed to be the snails which guarded Buddha from sunstroke, and it carries the mark on the top of the head. It has the large ears, with their lobes pierced and distended, but no ear-rings. The figure represents Buddha, after having taught his doctrine, merging himself into Nirvana. To an adept, the position of the thumbs and forefingers expresses a world of hidden meanings. The figure is luckily provided with a copious inscription which is couched in phrases anything but easy of translation. Its name is "the Buddha of the Five Wisdoms," and its motto, "All the world can share the blessings of Buddhism."

Biological Physiology.—The Director of the Marine Biological Laboratory (Wood's Holl, Mass.) for 1891 calls attention to the needs of physiology as one of the most important branches of biological science which, for want of room, has thus far been neglected. It is not animal or human physiology, as commonly understood, that the director has more especially in mind, but what he calls biological physiology, or the province of the biological economy of organisms. "It is in this almost new province that we meet the great problems of geographical and geological distribution, and those of the interrelations of species in both the animal and vegetable kingdoms. It is here that we study life-histories, habits, food; the influences of the physical environment, and the reciprocal relations, which are ever varying according to the issues of the universal struggle for existence. It is in this direction that experimental physiology finds one of the most inviting fields in the whole range of biology." As instances of what varied and interesting problems here await the experimenter, are mentioned the experiments of Pflüger and others to determine the influence of gravitation on the development of the egg; Boveri's experiments to determine where the formative power resides, and whether it is shared equally by both sexes; Fol's studies on fertilization; Auerbach's determination of the sexual distinction between the paternal and the maternal elements of the nucleus; Weismann's studies on the laws and causes of variation; the effects of chemical agencies on germ-cells as tested by Oscar and Richard Hertwig; the experiments of Beudant, Plateau, and Schmankewitsch in transferring animals from fresh to salt water, and *vice versa*; Semper's observations on the effect of the volume of water on the size of the creatures living in it; and others.

A Meteorological Poet.—A curious paper has been published by Naval Surgeon Grémaud, of Brest, France, on the tempest described in the first book of Virgil's Æneid. He answers some of the criticisms that have been made of it, and shows that the critics were not meteorologists. Having carefully compared the latest accounts of cyclones with Virgil's description, he has found the descriptions of the dangerous semicircle, the tractable semicircle, the plunging winds, and the columns of water rising like a wall and falling upon the ships to demolish them, correct; and establishes a complete analogy between them and the determinations of science. Hence, Virgil was not only a poet,

but a good meteorologist as well—one of the scientific men of his time. M. Vice-Admiral Vignes, President of the Geographical Society of Paris, on reading the paper, remarked that he was surprised to find in Virgil the exact laws of cyclones, which sailors did not learn till a comparatively modern time.

British Fisheries.—The North Sea fisheries of Great Britain were reported at the meeting of the British Association to be declining. It was proposed to draw up a history of the North Sea trawling grounds, comparing their present condition with their condition some twenty or thirty years ago, when comparatively few boats were at work; to continue, verify, and extend observations as to the average size at which prime fish became sexually mature; and to collect statistics as to the size of all fish captured in the vicinity of the Dogger Bank and to the eastward, so that the number of immature fish annually captured may be estimated; also, to make experiments with beam trawl nets of various meshes with a view to determine the relation, if any, between the size of mesh and the size of fish taken.

The Kingfisher.—The habits of the kingfisher (*Halcyon vagans*) are the subject of a paper by Mr. J. W. Hall, of the Auckland (N. Z.) Institute. His observations, while not decisive, favor the opinion that kingfishers capture live birds. They are also sometimes captured by hawks; but the hawk does not always come off best. One day the author saw a hawk sailing round the bend of a hill followed by a kingfisher. Then at once arose a great outcry, and the hawk came again in sight, bearing the kingfisher in its talons. But, nothing daunted, the kingfisher with its pickaxe of a bill pegged away at the breast and abdomen of its captor to such good effect that the hawk was glad to liberate its prey, whereupon the kingfisher flew away, apparently but little the worse for the encounter, and carrying with it the full sympathy of the onlookers.

NOTES.

THE Japanese observe very exact proportions between leaves and flowers in the arrangement of irises. With three leaves they use one flower, with seven leaves two flowers, with eleven leaves five flowers, with thirteen leaves only three flowers, and with fifteen leaves only two flowers again. When we examine pictures that show the results of the application of these rules, says Garden and Forest, we are convinced that they have been dictated by a very true feeling for artistic effects of the most delicate sort.

ACCORDING to the analyses of Dr. C. F. Millspaugh, of the West Virginia Experiment Station, weeds vary largely in the percentages of nitrogen, phosphoric acid, and potash which they contain. One of the evening primroses has only one per cent of nitrogen, while the poke-weed has three per cent of that substance, and a dry ton of the weed will contain twenty-two dollars' worth of it. By composting weeds with plaster, a valuable manure may be obtained.

ACCORDING to the story of George Hunt, keeper of the lighthouse at Tillamook Rock, on the Pacific coast, in the storm of December 7, 1891, the waves swept clear over the house, washing away the boats, and tearing loose and carrying off the landing platform and tramway which were bolted to the rock. On the 29th the waves were still higher, and streams of water poured into the lantern through the ventilators in the balloon top of the dome, one hundred and fifty-seven feet above the sea-level.

DR. ALANUS, a translation of whose letter relating his experiences is published in the Medical and Surgical Reporter, says that after having lived for a long time as a vegetarian without feeling any better or worse than he had felt with a mixed diet, he discovered one day that his arteries were showing signs of atheromatous degeneration. Consulting a work by Dr. E. Morin, of Paris, he found that affection pointed out as one of the results of living on an exclusively vegetable diet. He now no longer considers purely vegetable food as the normal diet of man, but only as a curative method of great service in various morbid states.

ACCORDING to an article in the Overland Monthly, many women in California gain a livelihood by raising flower bulbs and seeds for market, and many others send to San Francisco every day hampers of wild flowers and ferns which have been picked from the neighboring cañons. Mrs. Theodosia Shepherd, of Ventura, stands foremost among these successful floriculturists, although only eight years have passed since, without means and broken down in health, she grew her first seeds for market in the old mission town of San Buena Ventura. She now fills orders from prominent Eastern florists, with occasional calls from Europe, Australia, and the Sandwich Islands.

AN attempt has been made by Herr Pfeiffer to prove and measure, by the change in electric conductivity, the solvent action of

water on glass. He found that a cubic centimetre of water dissolved at 20° C. in one hour from one to two millionths of a milligramme from a square centimetre surface of glass; that with temperature rising arithmetically, the growth of solubility is considerably more rapid than that of a geometrical series; that the increase of conductivity of the water for a given kind of glass under like conditions is a characteristic constant; and that later, when a certain quantity of alkali is dissolved, further action involves a dissolving also of silicic acid, and the salts then formed may cause a decrease of conducting power.

A VEIN of asbestos has been found near Broken Hill, New South Wales, in which there are fibers thirteen inches long, of silky and flexible texture, but less tough than Italian asbestos. It is reddish in color.

THE sixth annual meeting of the Iowa Academy of Sciences was held at Des Moines, December 29th and 30th. The programme of discussions was full, and besides technical subjects of biology, zoölogy, petrology, etc., included several topics of domestic and other economical importance, such as the determination of the active principles of bread-making, the bacteria of milk, the effect of feeding on the composition of milk, sugar beets, the coal-bearing strata, brick and other clays, and aluminum in Iowa; the artesian well question, and the report of the committee on State fauna. The President of the Academy, Prof. C. C. Nutting, made an address on Systematic Zoölogy in Colleges, and Mr. J. E. Todd gave some Further Notes on the Great Central Plain of the Mississippi.

THE statement that the adoption of electric lighting in the English Savings-Bank Department has been followed by a considerable reduction in the amount of sick-leave points to what will probably be one of the chief advantages of this mode of lighting rooms. An electric lamp does not draw on the oxygen of the room, and does not give off irrespirable gases as do gas and oil lights.

ACCORDING to the Minneapolis Tribune, as cited in Garden and Forest, the leading opponents of the proposed forest reservation in northern Minnesota have become supporters of the measure. The Duluth Chamber of Commerce sent its secretary, Mr. Thompson, to the meeting of the State Forestry Association, to protest against the movement, but when he learned that instead of withholding the timber from use it was proposed to secure a constant lumber-supply, and that the forests when protected from fire and larceny would be more productive than they are under the present lack of supervision, Mr. Thompson himself joined the Association and was made a member of the Executive Committee, which is laboring to induce the President to make the proclamation withdrawing the forest lands from sale and entry.

A COLLECTION of letters and unedited memoirs by the Swedish chemist, Scheele, is in course of publication, under the direction of Baron Nordenskiöld. The question of preparing an English-American edition of the work is under consideration.

IN the Cambridge Antiquarian Society, November 11, 1891, Prof. Hughes described the results of his examination of some deserted Indian villages in Arizona, one of which consisted of caves excavated in the top of a small hill of lava; and another of dwellings built under the shelter of overhanging ledges in the cliffs of the Walnut Cañon, much resembling the cliff dwellings of mediæval times along the rivers of Dordogne.

STATUES of Boussingault, by M. Dalon, and Chevreul, by M. Fagel, are to be erected in Paris, in connection with the Conservatoire des Arts et Métiers. The Chevreul statue is a repetition of one executed by M. Fagel in 1889.

MANGANINE is the name of a new alloy, consisting of copper, nickel, and manganese, which has been brought into the market by a German firm, as a material of great resisting power; it having a specific resistance higher than that of nickeline, which has hitherto passed as the best resisting metal. It is said to be affected in only minute degree by high temperatures, and is therefore adapted for the manufacture of measuring instruments and measuring apparatus in general, which are required to vary in resistance as little as possible under different degrees of heat. While the resistance of other metals is increased by the raising of their temperature, that of manganine is diminished.

THERE is an art in dusting which does not receive the attention it demands. According to the various analyses of different observers, the components of ordinary dust exhibit special characters in almost endless variety. Mineral matters, animal and vegetable *débris*, morbid germs, and whatever is small and light enough to remain for any time suspended in the air, falls into the category; and among these things are many substances that in the air do mischief. The spread of cholera and exanthematous diseases has, doubtless with truth, been attributed to its influence. Methods of dusting, therefore, which merely remove the dust to another place or fill the air with it, are not sufficient and are not harmless. It should be wiped rather than brushed away, and carried away off, or destroyed. Then let the sunlight in to kill the infection that may remain.

AN examination of tinned peas, greened, by Drs. M. Charteris and William Snodgrass, of Glasgow, showed, by deposits on the crucible

and on the blade of a steel knife inserted into the gastric solution, the presence of copper. The copper and its albuminate were digested in solutions similar to those of the pancreatic and gastric juices, and in the stomach of the living animal. Administered to a rabbit and a pig, the salts of copper produced toxic symptoms.

A NOVEL rice-pounding machine used in the northern Shan states (Indo-China) is described by Lord Lamington as including bamboo pipes through which water is led into a hollow cut into one end of a pestle such as is usually worked by foot. The other or mallet end rises with the weight of the water till the water is automatically discharged, and then the pestle falls back and does its work of pounding the unhusked paddy.

THE *Acarus sacchari*, or sugar-mite, is very frequently found in raw sugar, but not in refined. In an inferior sample of raw sugar, Prof. Cameron found five hundred of the organisms in ten grains. They may be avoided by eating only refined sugar, but it is doubtful if they would do any harm if they were eaten. The disease known as "grocer's itch," however, is probably due to the presence of this mite, which works its way under the skin and produces symptoms identical with those produced by the common *Acarus scabiei*, and the remedies are the same for both. The parasites multiply very rapidly, and Gerlach found that a single female would produce fifteen hundred thousand progeny in three months. The most common agents for destroying them are mercuric chloride and sulphur.

DISCUSSING the value of the tree as a schoolmaster, Garden and Forest presents as the first of its lessons that "it teaches man to reserve judgment by showing that the insignificance of a germ is no criterion of the magnitude of its product, that slowness of development is not an index of the scope of growth, and proves to him that the most far-reaching results can be attained by very simple means. A barrel of acorns may be the nucleus of a forest that shall cherish streams to fertilize a desert; a handful of cedar cones may avert an avalanche, while a bushel of pine seed may prevent the depopulation of a great section of country by mountain torrents."

IT should be mentioned pertinently to President Jordan's article on Agassiz at Penikese, that the buildings of the Anderson School on that island were totally destroyed by fire in August, 1891. The fire caught—Mr. George O'Malley, of New Bedford, informs President Jordan—under one corner of the building, and in a very short time nothing was left.

THE Laboratory for Investigators of the Marine Biological Laboratory at Wood's Holl, Mass., will be open from June 1st to August 1st. The laboratory for teachers and students will be opened July 6th for regular courses of seven weeks in zoölogy, botany, and microscopical technique. The number of students will be limited to fifty, and preference will be given to teachers and others already qualified. Students may begin their individual work as early as June 15th without extra charge. A spacious new wing of the laboratory building will be ready for use on July 1st.

A SUMMER course in botany is held annually in the lecture-room of the College of Pharmacy, 209 and 211 East 23d Street, New York, to consist of ten lectures, beginning this year April 28th, and closing with the excursion of July 5th. The extensive appliances for instruction of the institution are used; fresh material is collected weekly; and competent lecturers are provided by a committee of the Torrey Botanical Club. In addition to the lectures, the course includes ten excursions. The lectures will be given on Thursdays, at four o'clock in the afternoon, and the excursions will be made on Tuesdays and Saturdays, each member choosing the series of excursions which he will attend.

THE fourth meeting of the Australasian Association for the Advancement of Science was held at Hobart, Tasmania, January 7th to 14th, under the presidency of Sir Robert Hamilton, and was in every way successful and creditable. The president, in his inaugural address, gave a sketch of the history of the Royal Society of Tasmania, and suggested reasons why all intelligent persons in Australia should do their utmost "to hasten the advent of the time, which is undoubtedly approaching, when science will form a much more integral part of the life of the people than it does at paesent." The next meeting will be held at Adelaide, and Prof. Tate will be its president.

OBITUARY NOTE.

DR. CHARLES MEYMOTT TIDY, an eminent English chemist and analyist, died March 15th. He had been joint lecturer on chemistry and Professor of Chemistry and Medical Jurisprudence and Public Health at the London Hospital, and was at the time of his death Official Analyist to the Home Office and Medical Officer of Health for Islington. He also held the office of Reader of Medical Jurisprudence at the Inns of Court. Among his publications were a course of Cantor Lectures on the Practical Applications of Optics to the Arts and Manufactures and to Medicine; a paper on the Treatment of Sewage; a work on Legal Medicine; a paper on Ammonia in the Urine in Health and Disease; and a Hand-book of Modern Chemistry, the second edition of which appeared in 1887.